Railway Engineering and Maintenance

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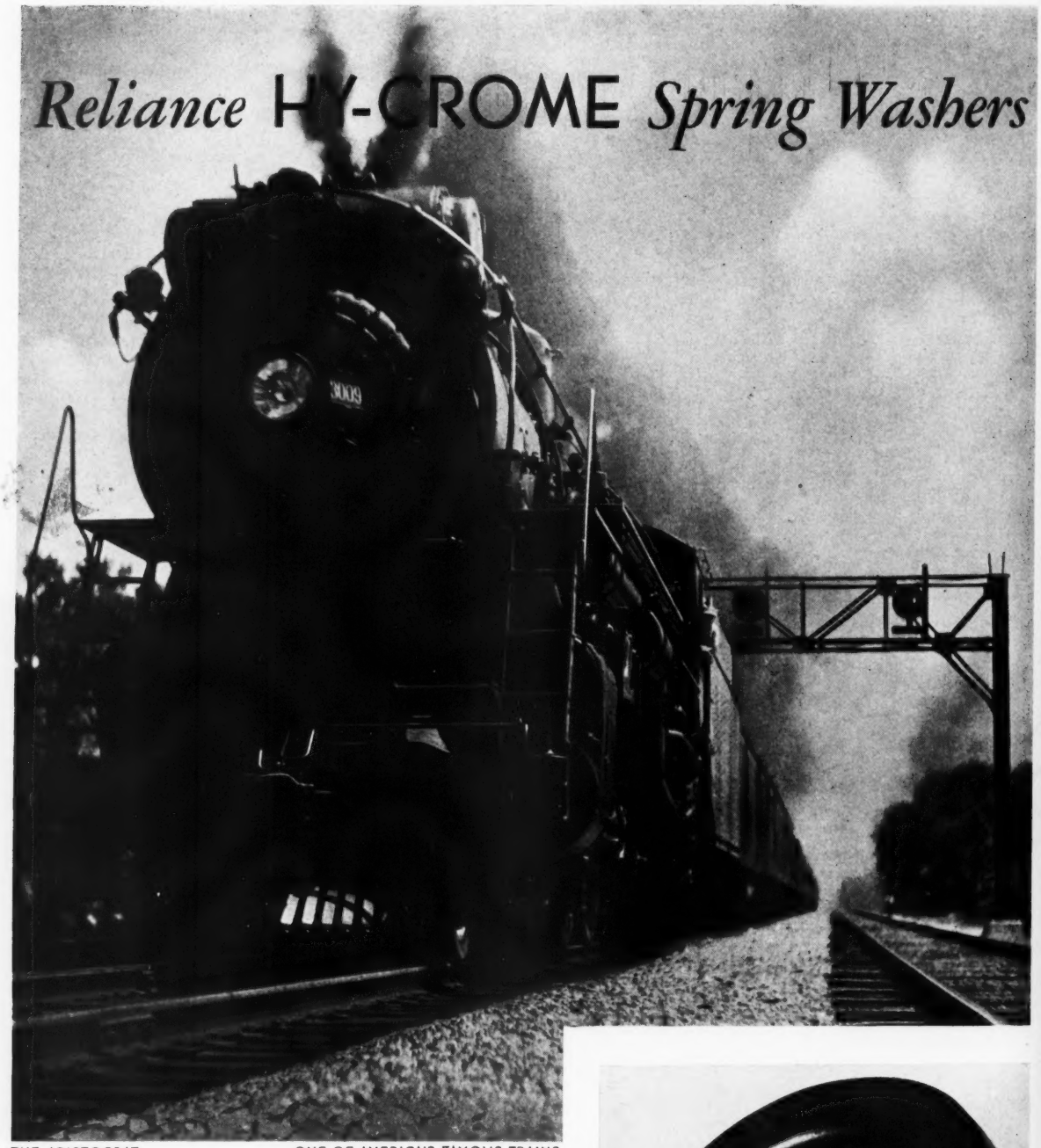
NEWARK, NEW JERSEY

Reliance HY-CROME *Spring Washers*



THE ARISTOCRAT ONE OF AMERICA'S FAMOUS TRAINS

THERE SHE GOES . . . on the middle track . . . rocking a little from side to side, which is the way of big locomotives when they hit their pace. Headed for Denver, the *Aristocrat* of the Chicago, Burlington & Quincy leaves Chicago powered by one of the 20 new hundred thousand dollar locomotives generating 3500 HP and capable of 85 miles an hour. Modern railroads today afford the luxury of the finest restaurant, the best club and the safety of travel associated only with railroads. Modern track appliances prove their greatest value in *maintaining* safety and smoothness of travel, and HY-CROME *Spring Washers* lower maintenance costs as well, *insuring* efficiency and economy.

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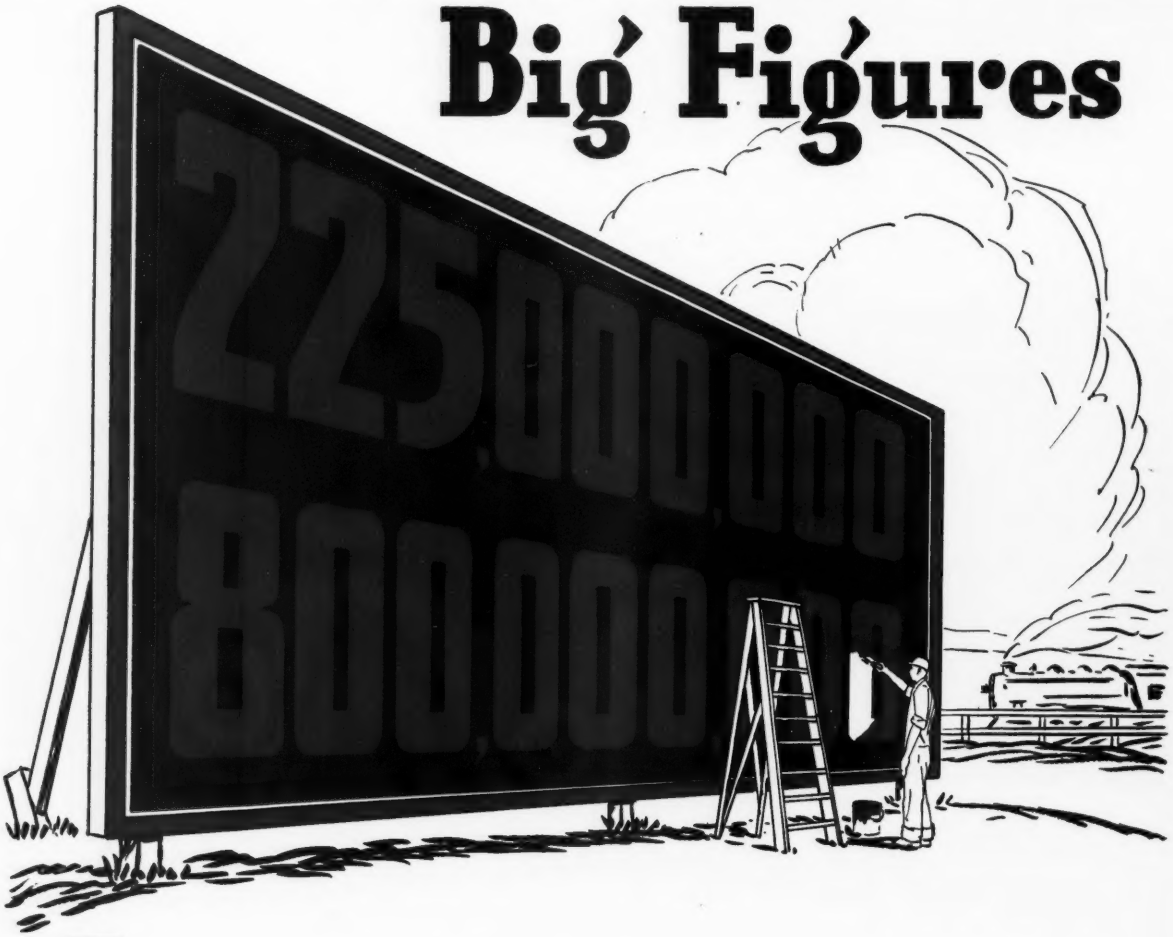

In the first six months of 1934, the railways ordered **$225,000,000** worth of materials and supplies from manufacturers, exclusive of fuel.

In the corresponding period last year their orders amounted to less than **$95,000,000**.

Large as these expenditures are, they are small in comparison with the needs of the railroads.

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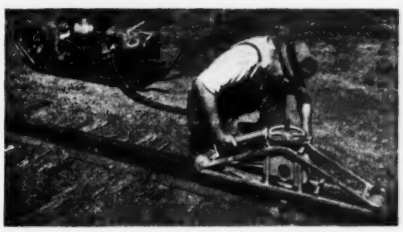
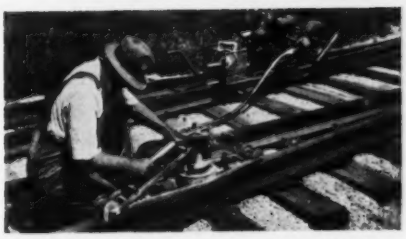


Preliminary grinding of welded joints with radial wheel.

Wheeled like a wheelbarrow.

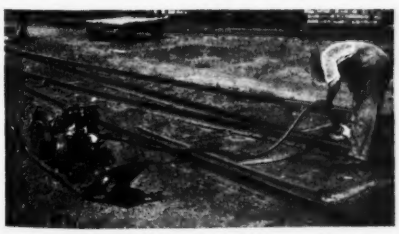


Finishing joints and removing mill tolerance. Very accurate.

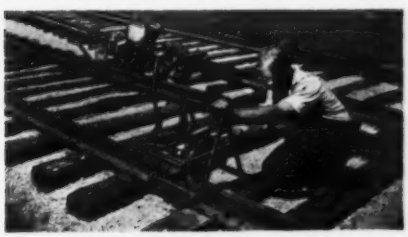
Grinding switch points faster with radial wheel.

Drilling holes for screw spikes.

Grinding switch points with cup wheel.



Will clear trains when between tracks.



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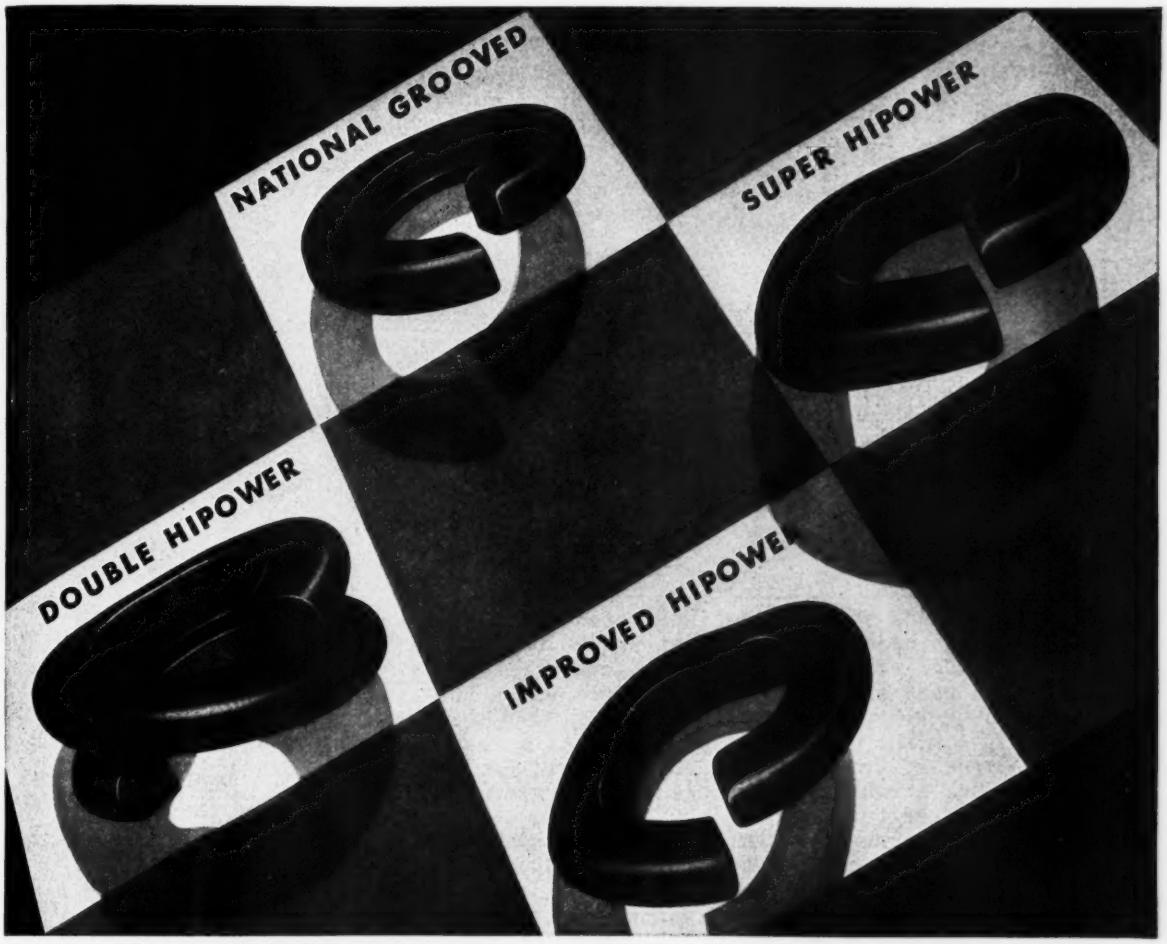

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NEWARK, NEW JERSEY, U. S. A.

No. 68 of a series

Railway
Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Our Oldest Reader

July 27, 1934

Dear Reader:

"I was greatly interested in your reference in your last issue to your oldest advertisers. This caused me to wonder who your oldest continuous reader is. Do you know?" So read an inquiry that we received a few days ago.

The question is not easy to answer. We could, of course, trace each of our several thousand subscribers back through our records year by year, but this would be a large task and the results would not be at all conclusive because of changes in addresses, the frequent sharing of copies by two or more men, etc. Rather, we believe that you can give us a more accurate answer and we are, therefore, asking those of you whose continued reading of Railway Engineering and Maintenance dates back ten years or more to write us, giving us your record.

As we stated in our last issue, Railway Engineering and Maintenance was first published as a separate magazine in May, 1916. Before that time it appeared for five years, or beginning with May, 1911, as a special section devoted to maintenance of way in the third weekly issue of the Railway Age each month.

We would like especially to hear from those of you whose continued reading of Railway Engineering and Maintenance antedates 1924. We would like even more to hear from those of you who have read the paper continuously since it first appeared over 18 years ago. Still more, we would like to hear from those whom we have served continuously since 1911. We solicit your co-operation.

Yours sincerely,

Elmer T. Howson

ETH*JC. Editor

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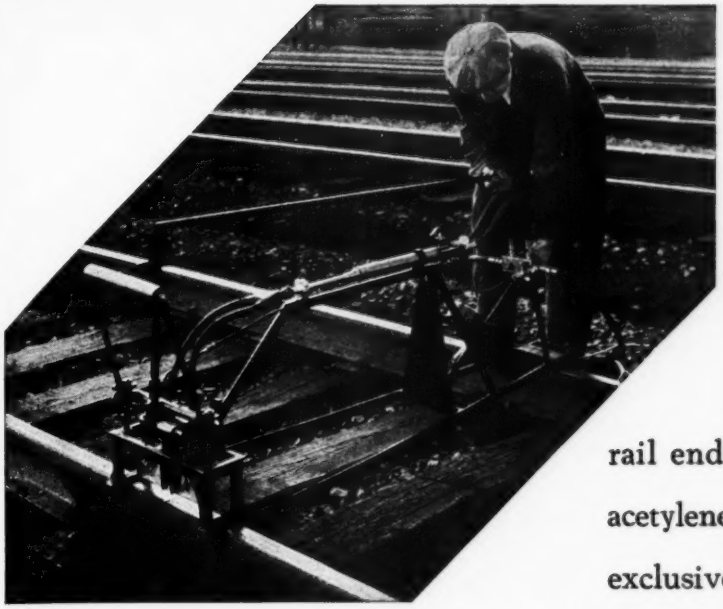

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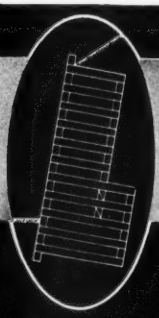
•AT GRADE SEPARATIONS•
•WHEREVER RIGHT OF WAY IS LIMITED•



•WHERE TRACKS ARE CLOSE TOGETHER BUT AT DIFFERENT LEVELS•
•TO STABILIZE EMBANKMENTS•
•TO PREVENT STREAM ENCROACHMENT•

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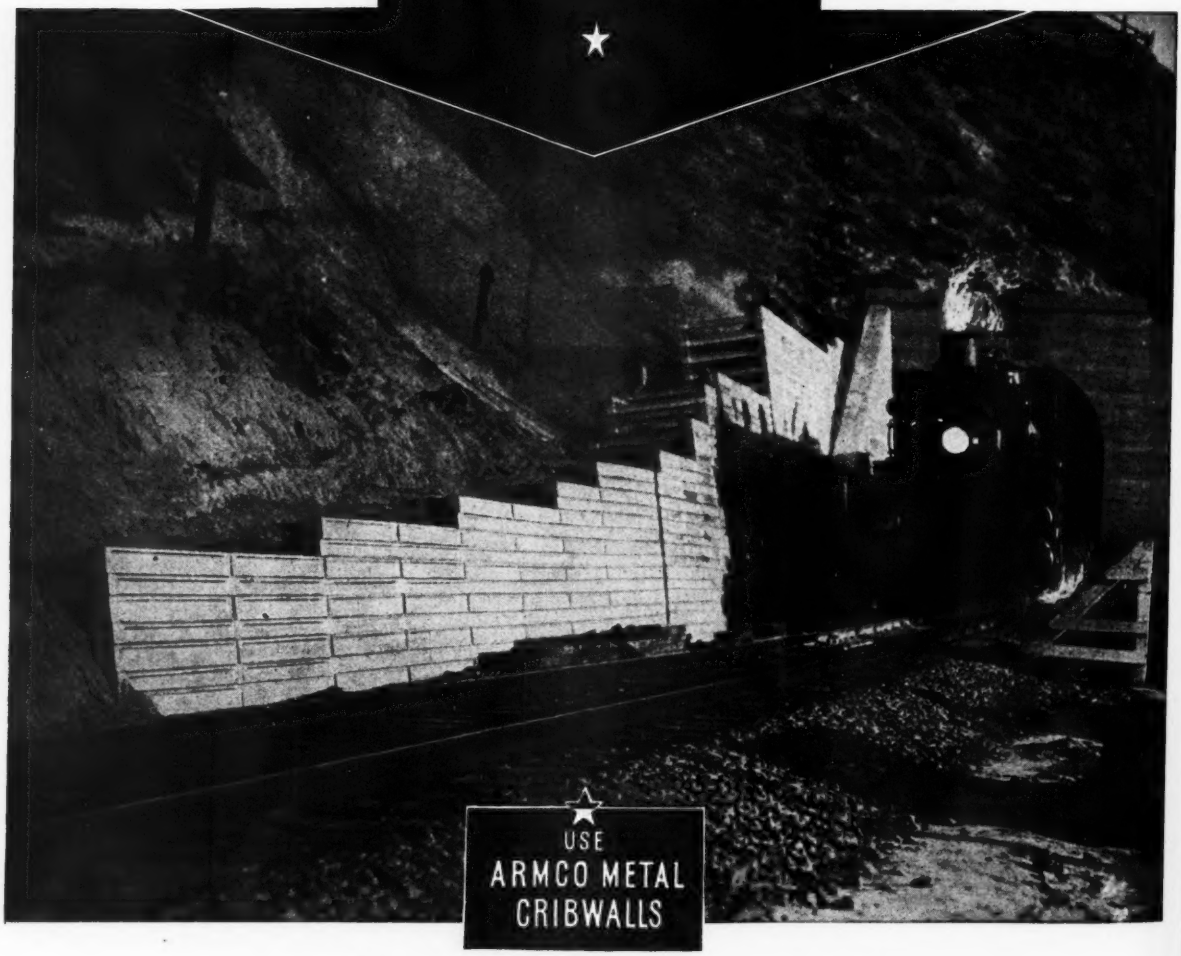

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Railway Engineering and Maintenance

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AUGUST, 1934

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Published on the last Thursday preceding the month of issue by the

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 West Adams Street, Chicago

NEW YORK
30 Church Street

CLEVELAND
Terminal Tower

WASHINGTON, D. C.
832 National Press Bldg.

SAN FRANCISCO
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Member of the Associated Business Papers (A. B. P.) and of the Audit Bureau of Circulations (A. B. C.).

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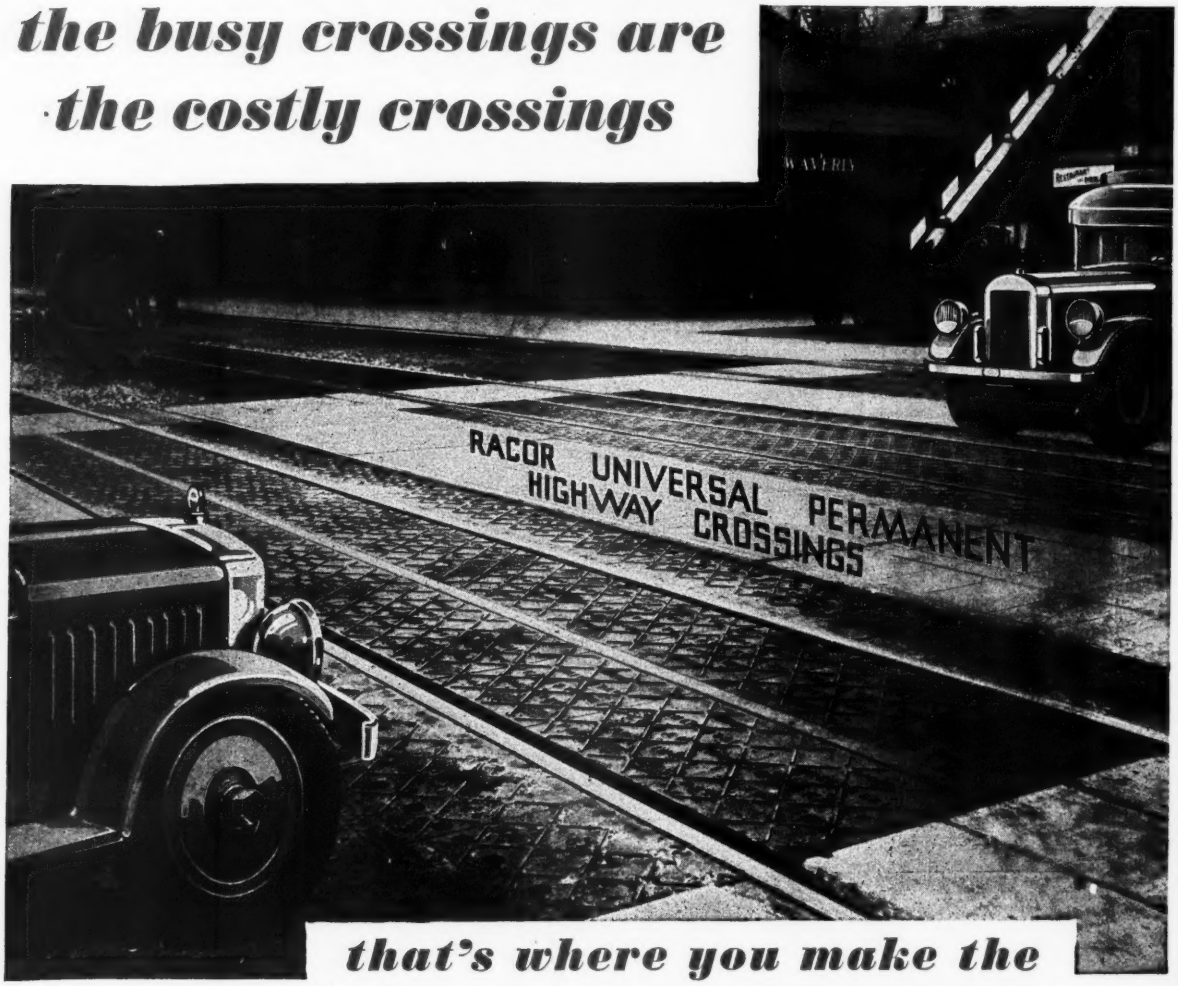
the busy crossings are the costly crossings



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Their return is in economy, in more years of good service and in good will from the public.

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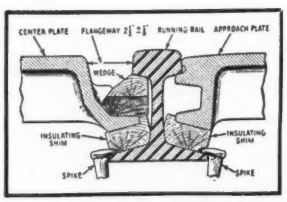

Section showing how Racor Crossings are supported by the track rail to maintain a constant level.

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Railway Engineering and Maintenance

INCONSISTENCY

In Treatment of Industry and Railroads

AS a cardinal principle of the New Deal, the present federal administration has set out to curtail production in practically all lines of activity. In industry, this is being accomplished through the NRA, with its limitation of hours of work, control of output, etc. In agriculture, the AAA is the agency, with its slaughter of pigs, its ploughing under of cotton, its reduction in wheat and corn acreage, etc. In these key measures the primary purpose is to so restrict output as to bring production in line with consumption and to wipe out existing surpluses. In transportation, however, the government is following an entirely contrary policy, an inconsistency which should be made known to every employee and every friend of the railways.

Railways Have Surplus Capacity

In common with other industries, the railways made vast additions to their plants during the years preceding the depression. In the period from 1923 to 1929, inclusive, they expended more than $7,500,000,000 for additions and improvements to their plants, entirely aside from liberal outlays for current upkeep and repair. As a result, they were not only in position to handle all of the traffic of the boom days without congestion or delay, but with greater efficiency than ever before.

Following the collapse of 1929, railway traffic fell off precipitately, in keeping with the recession in other industries. Decline followed decline until in August, 1932, the roads were handling only 48 per cent of the normal traffic for that season of the year. Since that time there has been some improvement, although the volume is still more than 40 per cent below normal for midsummer. In other words, the railways, with facilities adequate for the peak business of 1929, are today handling only slightly more than half that volume. They have surplus capacity available sufficient to handle all the traffic that may reasonably be expected to develop for some time.

Up to this point, conditions confronting the railways differ in no essential manner from those facing other industries. To prevent industrial cannibalism, however, the government created the NRA and through its agency has placed limitations on the further extension of facilities, that are designed to place a curb on excess production and utilize those surpluses that already exist.

With regard to transportation, however, a widely different policy is in effect. Here, in the face of a vast available and unused capacity on the railroads, the government is not only continuing but is greatly increasing the sums of money which it is allocating to the construction of additional highways, with full knowledge of the fact that, when completed, they will provide avenues over which additional motor carriers will operate to take traffic away from the railways. In like manner, the federal government is promoting the canalization of our inland waterways in the hope that they may provide additional channels on which water carriers may take still more traffic from the railways. In other words, the government, which is so assiduously curbing the output of farm and factory, is openly encouraging the construction of additional facilities in the field of transportation and is even providing the funds required therefor. Such is the inconsistency of the government's attitude towards the railways.

As privately owned properties, the railways have no inherent right to protection against the competition of more efficient agencies of transportation, if such there be. They do have a right, however, according to all the rules of fair play, to insist that this competition shall be on a basis of equality. They have a right, also, to expect the same protection that is accorded other industries—one form of which protection today is the prevention of the construction of added production facilities in fields already confronted with surplus capacity. Even more so, the railways should be entitled to know that the government will not devote funds derived from public taxation and credit to the aiding of its competitors. In other words, like the old woodsman, they have a right to expect that "if the government won't help them, it at least should not help the bear."

A Problem for Railway Employees

This is a problem that comes home to every railway employee. At a time when agriculture and industry are working short shifts and cutting down the volume of their products to be transported, there is less work for railway employees. This is a condition which they cannot do other than accept as a necessary corollary of the depression. However, when the government brings its vast resources to the aid of the railways' competitors and thereby diverts part of the already sorely reduced traffic to these competitors, there is just cause for complaint.

This is not a problem for railway managements alone. It is even more the concern of every employee of the railways whose income has been reduced or eliminated as well as of those whose security of employment is threatened. Railway employees should, in their own self-interest, make the present inconsistency of the government's attitude towards the railroads known to all with whom they come in contact and do everything in their power to bring about a more consistent policy.

CONVENTIONS

Constitute an Educational Opportunity

BOTH the Roadmasters and Maintenance of Way Association and the American Railway Bridge and Building Association will hold conventions this fall. These meetings are being held with the express approval of the railway executives, at whose request they, in common with other voluntary railway associations, suspended activities in the summer of 1931. Both associations will meet in Chicago on their regular dates, the Roadmasters on September 18-20 and the Bridge and Building men on October 16-18.

The resumption of activities by these two associations constitutes a step in the return to more normal conditions that is of importance to maintenance officers. Both organizations have long records of constructive service to their credit. The Roadmasters Association was organized in 1883 and met every year without a break until 1931. The Bridge and Building Association is only eight years younger and has maintained an equally continuous record. It is to their credit that they were among the relatively few associations whose activities were considered to be of sufficient value to the railways to warrant the railroad administration authorizing their continued activity during the critical days of the world war.

Both associations have maintained committee organizations during the last four years of enforced inactivity. The reports of these committees are now being completed for presentation at the conventions. Prominent railway men are also accepting invitations to address the meetings. Programs of practical value and interest are, therefore, assured. Furthermore, members of the supply associations which formerly exhibited at these conventions, are planning again to display their materials and equipment.

These conventions constitute an educational agency of real importance to supervisory maintenance officers and especially to those in direct charge of field forces. It is four years since these men have been able to meet and exchange experiences. In that interval many changes and improvements in methods have been effected. Many new men have also come into positions of supervisory responsibility. In this period morale has been shaken more deeply than is generally appreciated.

In this interval of four years there have also been vast changes in materials and equipment. Many improvements have been made; many new devices have been developed. The exhibits will afford these practical men opportunity to study and determine their merits. The opportunity to meet together will do much to broaden the viewpoint and raise the spirits of these men who have been struggling, each on his own subdivision or division, against heavy odds.

Recent years have witnessed many improvements in efficiency. With the many revolutionary changes in transportation practices in the offing and with the demands that are certain to be made for still greater efficiency of maintenance forces, it is necessary that supervisory officers be on their toes as never before. The conventions offer an opportunity for alert officers to bring themselves up to date.

There is still another aspect of these conventions to be considered this year. The executives of the railways have shown their appreciation of the value of these meetings by approving the resumption of activities. By this action they have placed on maintenance men a responsibility to participate in these meetings in the way that will be most beneficial to them individually and to the railways from which they come. It is in this way that they can demonstrate that the confidence of the executives has not been misplaced.

The conventions that will soon be held constitute an educational opportunity of the first magnitude. Maintenance officers owe it to themselves and to their roads to avail themselves of this opportunity and attend the meetings. Executive officers in the maintenance department can do much to increase the benefits to their men by encouraging their attendance.

BRIDGE STRINGERS

When Are Old Members Unfit for Further Service?

ONE of the problems confronting officers in charge of bridge maintenance is that of determining when the condition of bridge timbers is such as to require their replacement. The decision as to their suitability for further service is made after noting such visible defects as the size and location of checks and knots and the amount of decay present. In making this inspection and in arriving at a decision concerning the possible effects of the various defects present, the inspector has had to rely on judgment founded on experience, as there has been a dearth of specific information that could be used as a guide. He has known, for example, that a large check is a source of weakness. But to what extent?

As a consequence, bridge maintenance officers are constantly being confronted with such questions as: What effect do the size and location of knots have on the strength of the timber? Of checks and shakes? To what extent is decay a contributing cause of failure when present in stringers where they come in contact with the ties? How should bolt holes be located in order to minimize their effect on the strength of a member? Does decay around bolt holes exert any serious weakening influence? The list could be extended indefinitely.

Information recently developed as the result of tests conducted by the Forest Products Laboratory, Forest

Service, U. S. Department of Agriculture, at Madison, Wis., in co-operation with the Chicago, Milwaukee, St. Paul & Pacific, throws considerable light on some of these questions. As described on page 427 of this issue, the tests were made on 10 Douglas fir stringers that were selected at random from a quantity of timbers that had been removed from branch-line trestles of the railroad after 23 years service. These stringers were tested to failure under various types of loading, the effects of the various defects on the strength and manner of failure of the timber being carefully noted.

Bridge maintenance officers will profit by a careful reading of this article, including the list of recommendations that are given at the close. The value of these recommendations lies in the fact that they are based on the results of tests of full-size bridge stringers containing typical defects. They should be of material assistance in the evaluation of old bridge timbers.

TIE RENEWALS

Are We Bound Too Largely by Precedents?

WITH the exception of "Track Laying and Surfacing," the outlay for ties comprises the largest single item of expense in the maintenance of way and structures accounts. In 1929, it accounted for 12.7 per cent of the total, while in 1932, it amounted to 14.3 per cent. That the importance of this item is recognized is evidenced by the attention accorded the problem of determining annual tie allotments. It is manifested also by the frequency with which the subject of selecting ties for renewal is discussed. Tie renewal inspections were the subject of a report at the last convention of the American Railway Engineering Association and they have been actively discussed on various occasions before the Roadmasters' Association.

However, all these discussions have had one common characteristic. Much time and space have been taken in deciding when and by whom the inspection shall be made, but little has been said concerning *how* it shall be done, or, more specifically, on what criteria the ties shall be selected for renewal. In view of the wide range in standards of maintenance and the great differences in the processes of deterioration of woods of different species in different climates, the task imposed is no easy one. And it has not been made any easier by the general adoption of wood preservation, which has had the effect of extending the period between the time when incipient deterioration first becomes evident and the date of definite failure.

Most of those who discuss tie renewal inspections take the position that the practical track man knows or should know from intimate personal experience when a tie is ripe for renewal. But is this true? In recent years there have been frequent intimations that many foremen and not a few of their immediate superior officers have not realized fully the extent to which the rate of renewals should decrease with the introduction of treated ties and that they cannot overcome entirely the feeling that the renewal of no more than, say, 100 ties per mile, is inadequate.

It is for this reason that the study of tie renewals conducted on the Rock Island during the last three years, as reported on page 424 of this issue, is most timely. No process concerning anything subject to as wide variations as the physical condition of ties can be developed to the stage of an exact science. Personal equation is bound to assert itself, and misdirected zeal with the objective of reducing renewals to a minimum can easily be carried too far. It is not to be expected, therefore, that the methods described insure absolute perfection. It does appear, however, that the Rock Island has directed attention to a track maintenance practice that deserves careful investigation, conducted with an honest disregard for long-standing precedent.

MAINTENANCE

Expenditures and Employment Increasing

WITH total operating revenues for the first five months of 1934 exceeding those for the corresponding period of last year by 18.5 per cent, and with the net railway operating income showing an increase of 93.8 per cent, the railways are undertaking more liberal maintenance programs. This is demonstrated by the figures on expenditures that are now being released from month to month.

In May, the latest month for which statistics are available, the Class I railroads spent $35,048,894 for maintenance of way and structures. This figure compares with $30,133,285 for April and represents an increase of 28.3 per cent over the total of $27,322,978 for May, 1933. In fact, the expenditures for May, 1934, were greater than those of any previous month since November, 1931. The outlay for maintenance of way and structures for the first five months of 1934 totalled $143,971,691, compared with $118,694,562, or an increase of 21.3 per cent.

While no figures on the money expended in June are yet available, a very good index of the continued activity in maintenance of way work is to be had in the recently published statement on employment as of June 15. On that date, 236,584 persons were employed in maintenance of way on Class I railways, or 53,671 more than in January. This total compares with 227,385 employees in May, and with 204,663 persons in June, 1933, and represents the largest force engaged in maintenance of way work in any month since October, 1931, with the single exception of May, 1932, when the total was only 173 greater, or 236,757. The average number of employees for the first six months of 1934 was 203,069, compared with 187,116 during the first six months of the previous year.

Both the Track and the Embankment Were Completely Destroyed at Six Points for Distances Ranging Up to 1,500 Ft.

Meeting Nature at Its

IT WAS no easy task that confronted the maintenance of way department of the Colorado & Southern late in 1933, when it became necessary to restore more than seven miles of track and roadbed in a narrow, precipitous and nearly inaccessible canyon having only one point of entrance, which had been almost totally destroyed by floods following two cloudbursts of great severity, which occurred only a few weeks apart. The line involved is the Clear Creek branch, a narrow-gage line, which extends from Denver, Colo., west 54 miles, to Silver Plume, near the summit of the Continental Divide. This line is particularly well known by reason of the famous Georgetown loop which is located high up in the mountains between Georgetown and the terminus at Silver Plume.

From Mile Post 17, one mile west of Golden, to about Mile Post 35 near Idaho Springs, the line lies in Clear Creek canyon, a deep, narrow, crooked gorge with unusually precipitous and generally bare rock walls, which in places overhang the roadbed. It was in the lower 7½ miles of the canyon, between Mile Post 17 at the mouth and Mile Post 24½ at Elk Creek, that the line suffered the severe damage following the two cloudbursts. The rise in this distance is 842 ft., or an average of 120 ft. to the mile, but there are numerous places where the grade is as heavy as four per cent.

When the road was constructed, about 1872, to reach the feverishly active gold and silver mining sections high in the mountains, the grade was established well above such high-water marks as were available. That this was done carefully is attested by the fact that for more than 60 years only minor highwater trouble had been experienced, being such as might be expected from erosion by the closely confined waters of a mountain stream during high stages.

In constructing the line where the gorge is narrowest or the walls are the steepest, it was necessary in many places to blast the roadbed out of solid rock, the broken rock thus obtained being used in adjacent embankments. In other places, no other material being available, rock was quarried in this manner expressly for embankment purposes, or obtained in part from the bed of the stream. In still others, some earth and decomposing shales were available, and these were used so far as practicable.

Nothing Like This Had Ever Happened Before

Late in July, 1933, a cloudburst of short duration but unusual severity occurred over a restricted area in the vicinity of Elk Creek, all of which area was in the drainage basin of the canyon. In fact, although sudden and violent rainstorms are common in this section during the summer months, no rainfall of similar magnitude is known to have occurred within the drainage area along this line since the date of its construction. While there is no record of the total precipitation that occurred during the short duration of the storm, the severe damage caused by the resulting runoff, accelerated by the steep slopes, is ample evidence that it was abnormal. Not only was the track submerged in places, but there were many serious washouts, and some embankments were completely destroyed. At many other points the

track was covered with sand, gravel, large stones, drift and soil which were washed in and deposited by water from side gullies.

For years after the line was completed, mining was continued on a large scale and traffic was heavy. Eventually, however, the gold deposits had been worked out so that mining activity was much reduced and, because of the low price of silver, had practically ceased during recent years. As a result, traffic was correspondingly reduced, until at the time of this storm, only irregular service was being maintained on two days a week.

Mountain torrent destroys seven miles of track and roadbed, in many places leaving only bare rock walls in deep, narrow and nearly inaccessible canyon

For this reason, serious consideration was given to the abandonment of the line, and the work of making repairs was deferred until this matter was decided. In the meantime there was a revival of interest in silver, with a prospect for higher prices. This gave promise of renewed activity in mining and it was decided to repair the line and restore operation. Accordingly, the forces were being organized and the necessary material and equipment were being assembled when during the afternoon and night of September 19, there was a second cloudburst in the same territory, of greater severity and far longer duration, which covered a much larger area than the July storm.

Worst

Although no record of the rainfall during this second storm was obtained, there is considerable evidence that it was greater than that of the July storm. In any event, the volume of floodwater was much greater, and the flood reached a higher stage and continued at this stage for a longer time, while it greatly extended the damage that had already been done. The line was inspected as soon as the flood had receded so that it was possible to enter the canyon, and it was found that the track had been submerged over much of the distance between Elk Creek and the mouth of the canyon. As a result of the two storms, the embankment was partly washed out at 41 separate places, this damage extending from a few feet up to 1,000 ft. or more. In addition, both track and embankment were completely destroyed at six points for distances ranging up to 1,500 ft., while at other places the track was covered with debris to a depth varying from a few inches to several feet.

Many of the protection walls which had resisted all previous floods were either badly damaged or totally destroyed. At the six points mentioned, the roadbed was stripped to the bare rock, so that at these places only the canyon walls remained. Immediately below Elk Creek station, the stream widens noticeably for several hundred feet, and this place had been selected to establish a crossing from the left to the right side of the canyon by means of a through truss span. Almost with the first rush of water during the second storm, the channel shoaled under and immediately below the bridge, with the result that the flood water topped the roadbed and washed out the embankment, cutting a new channel back of the downstream abutment, and continued its erosive action for several hundred feet, destroying the embankment, to a point where the canyon turns abruptly to the right.

Flood Raises Bed of Stream to Track

Shoaling of the channel occurred at only one other point, although gravel bars were formed or enlarged at many of the bends. At Guy Gulch, about five miles west of Golden, there is an abrupt widening of the canyon walls to about 200 ft. at the track level for more than a quarter of a mile, and the gradient of the stream bed is perceptibly flatter. Because of this, stream action had built up along the right bank a relatively high shelf of coarse gravel and stone to a width of about 50 or 60 ft., and soil had been washed in from the side to cover it, thereby providing a favorable location for a passing siding and a set-out track. During the flood, the water deposited enough of its burden of suspended matter in the flattened section of the channel to build up the bed of the stream nearly to the elevation of the track, thus making it probable that even minor floods in the future would submerge the track in this section.

To reduce the probability that the extensive damage which occurred at this time would be repeated during future floods, all embankments, except one, were replaced with stone, for which purpose a quarry was

Excavating a New Channel at Guy Gulch

opened near the mouth of the canyon about one mile west of Golden. All of the embankments as far as Guy Gulch were either repaired or replaced with stone from this quarry. In some cases the protection walls were rebuilt with heavy stone laid dry. In others, the new protection consists of a heavy blanket of large stone specially selected for this purpose.

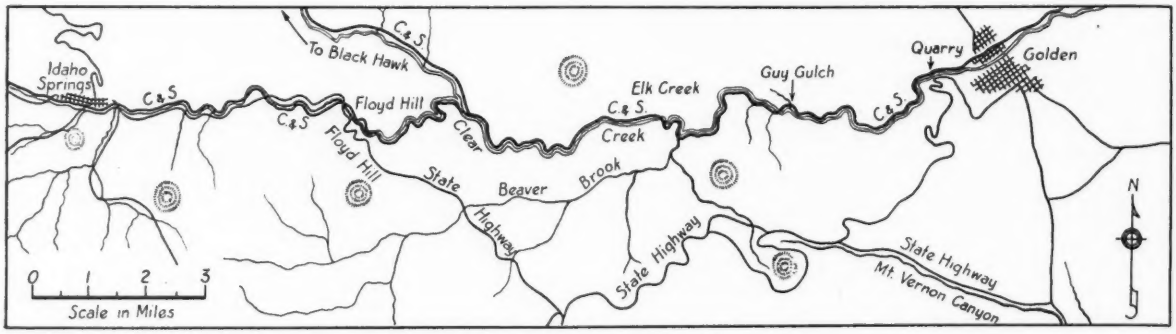
At several points between Guy Gulch and the mouth of Beaver brook, where the damage was greatest, owing in part to the abruptly crooked alinement of the canyon and in part to the fact that in this part it is at its narrowest, the alinement of the track was modified to the extent that conditions made practicable. This was done to avoid the maintenance of embankments at the more exposed places, but in part also to reduce the curvature around some of the sharp points or noses of rock. At no place, however, was the line thrown back far enough to require a tunnel, although all of these relocations required that the roadbed be excavated through the solid rock of the canyon walls, the spoil being used in adjacent embankments.

Only one bridge was carried out by the flood, this being the one over Beaver brook, the largest tributary within the zone affected by the storm, which enters the canyon about 1½ miles west of Guy Gulch. This structure was replaced by a creosoted-timber trestle with bents resting on concrete footings.

The Extent of the Damage Was Determined by an Inspection on Foot

As the mouth of the canyon near Golden afforded almost the only means of access to any part of it as far west as Elk Creek, it became necessary to carry on the repair work progressively from this single point of entrance. The one exception to this procedure was made in the case of some grading immediately west of the mouth of Beaver brook, where the roadbed was totally or partly washed out for about one-half mile. This is the only place between Elk Creek and Golden where the canyon can be entered from the side. The trail leading into the canyon, such as it is, is steep, narrow and had been unused since early mining days, but to conserve time, teams and scrapers were brought in with considerable difficulty to repair and restore this section of the roadbed. In this way the new roadbed was ready for laying track by the time the several short relocations and the reconstruction of the Beaver Brook bridge were completed.

While a considerable part of this new fill is rock, much of it is of small size and the remainder consists of disintegrated shale and other relatively fine material. These materials, although easily eroded, were used because they were all that were available, the alternative being to wait until the track could be restored to this point, thus appreciably delaying the date of completion. A heavy dry stone wall was constructed to protect this fill.



Map of the Line Between Golden and Idaho Springs

No material suitable for restoring the roadbed was available at Elk Creek. That which had formed the bar under and below the bridge consisted generally of sand, finely broken shale and small gravel, which might be expected to erode easily if used to replace the roadbed. Here, the canyon wall rises about 300 ft. almost vertically before it begins to slope, so that the track could not be set farther back from the channel. In addition, such a change in alinement would have required considerable additional solid-rock excavation to get around the point a short distance below the bridge.

To obtain suitable material, it was decided to go to the top of this cliff and blast off the amount of rock necessary to make the fill, an unusually difficult piece of work. Not only was it necessary to make a wide detour to reach the top, but there were no trails, and the drills and other tools, as well as the explosives, had to be packed over steep mountain slopes where the footing was at all times precarious. As there was no shelter, the men were required to return over the same route in the evening, bringing back drills that required sharpening. All drilling was done by hand on slopes where a misstep meant certain death. Despite these handicaps, this part of the work was completed without accident.

Mention has been made of the manner in which the bed of the stream was built up opposite the siding at Guy Gulch. The accumulation left by the flood waters was at such an elevation that there was danger that the track would be submerged during ordinary high water. To remove this danger, a power shovel was employed to excavate a new channel well away from the shelf occupied by the tracks. One of the illustrations shows this shovel at work, together with the levee that was thrown up between the new channel and the track.

While this job of restoration was unusual in all of its

aspects, probably the most striking and interesting incident of the entire schedule was the movement of a steam locomotive over 29 miles of mountain highway. On the night of the July flood, all of the locomotives on this line were at Denver and there was no possibility of getting one west of Elk Creek until the line had been restored. To accelerate the work, however, it was necessary to provide some means of handling rail, ties and other materials, as well as the forces for applying them, at the Elk Creek end of the break. The nearest point available for delivering material or for getting a gang and its tool equipment into the canyon is at Floyd Hill, eight miles west of Elk Creek, where an improved state highway crosses the track at grade. Obviously, the narrow-gage motor cars with which the section gangs were equipped were inadequate to handle either the material or the construction gangs and their tools.

Confronted with this situation, the transportation problem was solved by arranging with the Colorado Fuel & Iron Company for the loan of a narrow-gage, saddle-back switch engine. This locomotive, which weighed about 37,000 lb., was loaded on a standard-gage flat car at Pueblo, Colo., and shipped to Denver. Here, by means of a crane, it was transferred to an automobile trailer truck, on which it was hauled through the streets of one section of Denver and to the foot of the mountains south of Golden. From here the route was through Mt. Vernon canyon and over the highway through the mountain park system of the city of Denver, thence down Floyd Hill, a total distance by highway of 29 miles. That part of the route from the entrance to

At Elk Creek the Flood Washed Out the Roadbed Below the Bridge

Mt. Vernon canyon to the foot of Floyd Hill can easily be traced on the accompanying map. At the foot of Floyd Hill, the locomotive was transferred from the trailer to the rails.

To fully appreciate the transportation problem involved in this movement, it should be borne in mind that, in common with all other highways which ascend the eastern slope of the Rocky mountains in this section, the roads over which the locomotive was routed have many sharp curves and steep grades. Owing to the heavy gradients encountered, two Coleman trucks pulling in tanden were required for the haulage.

Enormous Boulders Moved by Flood

In the general disintegration of the canyon walls throughout centuries of weathering, frost action and erosion, many rocks of great size have fallen into the channel of the stream. A number of these immense boulders were shifted by undermining or by the pressure of the flood waters to new positions where they either blocked the channel in such a manner as to build up the bed of the stream or deflected the current against the roadbed. To guard against damage from this source, many of these stones were drilled and broken with dynamite into sizes that would remove this hazard. In one or two instances, they were left by the flood in such positions that they could be incorporated in, or used as part of the protection for, the restored roadbed.

Substantially all of the rail on the section of the line

This Locomotive Was Moved for 29 Miles Over Mountain Highways

affected by the two floods had been in service since the line was constructed, being a 52-lb. section of steel rail rolled in 1871. Some of it was washed away or covered up in the bed of the stream and was not recovered. Much of the remainder was bent and twisted beyond the possibility of further use. All of the damaged rail, aggregating more than two miles, was replaced by a 60-lb. section of relayer rail.

At the time of the second storm, the preparations for repairing the damage created by the first storm, had progressed to the point where the maintenance forces were ready to begin work as soon as conditions in the canyon permitted the use of work trains. Accordingly, the quarry was opened on September 25. By October 5, the embankments were restored and the track cleared of debris as far as Guy Gulch.

In the meantime, the preparatory work for relocating the line at the selected points above Guy Gulch, and for replacing the Beaver Brook bridge, was being carried forward, so that these items might be completed quickly after the necessary material and equipment could be brought in. Simultaneously, the team outfit was put to work west of Beaver Brook, and the quarrying operations were started at Elk Creek. By working simultaneously at such points as were accessible, the line was connected through on October 25. On that date, except for a few minor items, all of the work was completed save the reconstruction of the protection walls, the laying of which was deferred until the line was restored to operation.

Arrangements were made with the Hamilton & Gleason Company of Denver, general contractors, under which this company provided all of the equipment used on the work, except locomotives, cabooses and an air compressor. It also provided all of the superintendents, foremen and both skilled and unskilled labor for restoring the roadbed and completing other items that have been mentioned, except track labor, the trackwork having been done with the railway's own forces.

The work was organized and carried out under the general direction of R. C. Gowdy, chief engineer. A. P. Briggs, assistant engineer, was in charge of the field work. T. P. O'Neil, engineer maintenance of way, was in charge of track work.

When Should a Tie Come Out?*

By JOHN B. MABILE

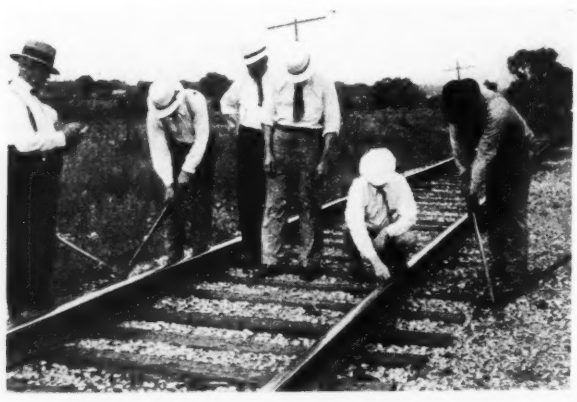
General Maintenance Inspector, Chicago, Rock Island & Pacific

The Roadmaster Cannot Walk Over Every Mile

IN THE nine years 1921-1929, inclusive, the Chicago, Rock Island & Pacific renewed an average of 145 ties per year per mile of track maintained. In 1930, the renewals averaged 130, in 1931 they were reduced to 99, in 1932 to 37, in 1933 they were 45, and our estimate for 1934 is 60 ties per mile. Considered off hand, these figures would seem to indicate that the replacements made in 1932 and 1933, and contemplated for 1934 are grossly inadequate and that this record comprises an example of steadily increasing deferred maintenance. Our answer is that we are making no predictions concerning our crosstie requirements next year or the year following, (except for supply) and that we know that the renewals being made from year to year are adequate to insure safe track and that the reduction in the number of ties being renewed can be accounted for largely by the fact that we are now taking out only the ties that should come out, whereas in former years, many ties were removed that should have been left in the track. It is also a fact that while ties were removed prematurely other ties were left in the track that should have been removed.

In making these statements, we do not claim superior ability in the detection of ties that have reached the end of their service life or of determining with any greater accuracy than others, what ties may be allowed to remain in track without increasing the hazard of train operation. What we do contend is that we have developed a more accurate method for selecting ties for renewal and we are educating our men. We are convinced also that the determination of the annual tie renewal requirements on most roads today is too largely a matter of established precedents and that not enough thought is being given to serious study of the problem.

*Rewritten from a talk before the Maintenance of Way Club of Chicago.



Checking the Foreman's Selection of Ties for Renewal

These conclusions are based on observations during the last three years in the course of which I have walked more than 1500 miles of track and talked with maintenance men of all ranks in an effort to learn their opinions and compare their skill with my own in judging the condition of ties. It had become my task to check the requests for ties prepared by the division officers, with a view to effecting all possible economies in the annual replacements, and I knew no better way to approach the problem than to go out on the track and see how it was being done.

Through my own experience as a roadmaster, I was thoroughly familiar with the established custom of placing the responsibility jointly on the section foreman and the roadmaster. However, I knew also that the rule requiring a roadmaster to walk over each section with the foreman for the purpose of checking the tie renewal requirements was not being enforced because their subdivisions have been so greatly extended during the last four years as to preclude rigid adherence to this rule. There is still another reason why the roadmaster cannot be expected to function effectively in any such routine inspection. To check all the ties in 100 or more miles of track takes time, during which dozens of other matters demand a roadmaster's attention which he has difficulty in keeping out of his train of thought when he should be concentrating on ties.

Although maintenance officers have been confronted for one hundred years with the task of determining what ties were ripe for renewal, the author of this article contends that he has developed a new procedure, the application of which has resulted in a reduction in renewals without sacrificing safety.

But there is still another defect in the usual practice of making allotments of ties for renewal. Under the system commonly in vogue, the foreman, the roadmaster and the division engineer or division superintendent each prepares estimates, in turn, of the requirements for the tracks under his immediate charge, only to have the officer next higher up review his findings and modify them arbitrarily. When I was a roadmaster, I got caught one year by a drastic cut in my estimate, but it didn't happen a second time. In other words, under the practical application of this plan, the man down the line is prone

This Tie Looked Sound But It Was Broken off in the Bending Test

At the left — The Bending Test—A Pick Serves as a Fulcrum for the Lining Bar

Below—Testing a Tie for Spike Holding Power

to introduce a factor of safety in his estimate to compensate for the reductions that are almost certain to be made by some superior officer.

It was with this background that I assumed the task in the fall of 1930, of bringing about greater uniformity and economy in tie renewals, and for the lack of any better way I started out to check the ties marked to come out in one mile of each division. I soon learned that the trackmen in territories remote from points of tie production could find many more reasons for leaving a tie in the track than foremen and roadmasters who saw freshly cut ties every day stacked up along the right of way ready to be loaded out. In fact, the men in the tie producing areas seemed never to get enough new ties. I also learned that section gangs almost invariably found it necessary to renew more ties near the section headquarters than they did at the remote ends of their sections.

However, the most important fact that I discovered was that no two men could agree on the selection of the ties to come out, regardless of the amount of time and care taken in walking over the track. This observation was made after repeated tests, in which the roadmaster, the division engineer and I, and, sometimes also, the engineer maintenance of way would walk over a stretch of track at sufficient distances apart to insure that each man would make his own selection uninfluenced by anyone else. In most cases, we would not differ greatly with respect to the number of ties to be taken out in a given distance, where tie conditions were worst, but when we compared our selections of actual ties, where track was better tied, we would find wide variations. Furthermore, subsequent experience showed that estimates of the number of ties requiring renewal, based on the usual surface inspection, often missed the mark by a wide range.

What We Learned on One Mile

This can best be illustrated by reviewing our experience on the St. Louis division, between Mile Post 129 and Mile Post 130. The division had asked for 330 ties for renewal in this mile in 1931 and when I cut this estimate to 179 ties, there were intimations that I had shown a reckless disregard for safety. When I went over this mile again in January 1932, I found that no ties whatever had been renewed, and I approved the request for 179 ties for 1932. However, in the fall of 1932 I learned that only 77 ties had been applied and in making our definite inspection we found that 23 ties were required for 1933. In arriving at this figure some allowance was made for curves. Only 15 were inserted in 1933, as the foreman found that eight of the ties we questioned were still good, and the estimate for 1934 is 34 ties. If we are to assume that those 34 ties will be applied this year, it will mean the renewal of 126 ties in the course of four years, following an inspection that had convinced the roadmaster that 330 ties should be taken out in the one year.

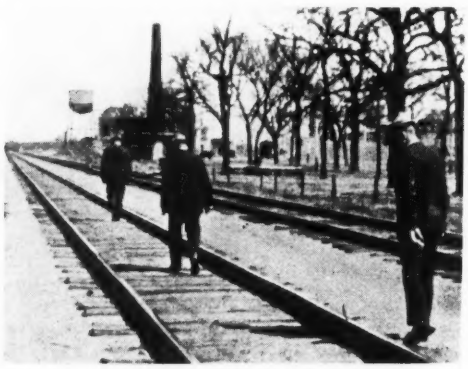
What is the answer? I have become convinced that it is impossible to judge the condition of ties made from many species of wood by the appearance of the surfaces that are exposed as they lie in the track. Too many ties decay most seriously on the lower side where it cannot be seen. This was discussed with many foremen, roadmasters and other maintenance officers, and the question asked by one of the older foremen, "Isn't there something we can do besides look at them," finally led to the plan that we have adopted.

The primary functions of a tie are to hold the rails to gage and to provide an adequate support for the loads applied to it by the rail. Its ability to perform the first function can be judged readily by noting evidences of adequate or inadequate holding power of the spikes. However, we are of the opinion that it is not necessary to remove every tie that shows poor spike-holding power, especially if the ties on each side of the one that is de-

fective in this respect are holding the spikes well. Furthermore, we do not adhere to the rule of esthetics that the spikes outside the rail should be in the east half of the tie and those inside the rail should be in the west half of the tie, or vice versa. Although the appearance may not be as attractive, we do not hesitate to reverse the order of the spiking if this will put the spike in sounder wood.

A Test of Strength

The other requirement of the tie, that of providing adequate support for the rail and the load it carries, cannot be judged by looking at it. The condition of the rail seat cannot be seen because it is covered up. In fact, the most reliable index of its bearing power is the holding power of the spikes. It is our experience, also,



Selections Based on Independent Visual Inspections Sometimes Vary Widely

that appearances are especially deceptive when judging the strength of a tie as a beam in distributing the load to the ballast. For this reason we have adopted a bending test as the principal criterion in deciding whether a tie is to be removed. This test is made by digging the ballast away from the ends of the tie sufficiently to permit the end of a lining bar to be thrust under it so that the tie may be pried up, while a pick held close to the end of the tie serves as a fulcrum. In doing this, the man on the bar not only applies his full weight on its extreme end but also works it up and down like a pump handle.

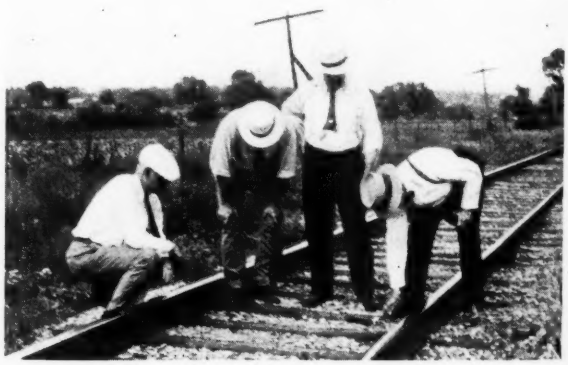
In some cases, of course, this test serves only to verify judgment based on the visual inspection. The end of the tie breaks off or the end of the bar is forced up through soft, punky wood. But some of the results are surprising. Not infrequently, a tie that looks perfectly sound on top will break off with but little strain on the bar. On the other hand, a tie showing rather general rot on the top will resist the bending test indefinitely. The same is true often of pole ties that are so badly split through the heart that the force applied by the bar must be resisted by only one side of the tie, yet without resulting in failure.

This procedure insures the removal of all ties that are too weak to distribute the load to the ballast, but we realized of course, that this test alone would not provide a complete answer. As a consequence, we developed some general rules or principles that may be said to express the objective we are after in our tie renewals, namely, to keep the tracks safe without wasting any money. In other words, in addition to removing all failed ties, it is our policy to remove doubtful ties, that is, "spike killed" ties or ties that have become badly split or ties that have been adzed to an excessive depth, in all cases where the ties on either side are somewhat weak. We also give preference to joint ties. Our rules with respect to highway crossings is that no provision shall be made for new ties, unless the crossing pavement is scheduled for renewal or overhauling, in which case we provide enough ties to insure first class condition, and any ties removed that still possess some service life are reinstalled in side tracks.

In general, it is our policy to remove only the failed ties from a track that will not be subjected to other than ordinary maintenance during the ensuing year. We are convinced that this policy is sound from the standpoint of economy, and further than this, we doubt whether a new tie inserted in track by "digging in" will provide any better support for the rail than an old tie of limited strength bedded solidly in the ballast.

Getting the Idea Across

Having concluded that this plan for testing ties for replacement was an improvement over our former practice, the next step was to introduce it on the system. Right here I want to say that, as I saw it, my job was to get the foreman and the roadmaster to apply this method themselves rather than to use it myself merely as a check on their tie renewal recommendations. However, it seemed to me that the plan could best be demonstrated at the start by employing it as a check. To this end it was arranged that a party consisting of the roadmaster, the division engineer, and the writer would apply this method on one mile of track on each section, with the assistance of the section gang. The foreman was urged to ask questions and encouraged to express his own opinion; every effort was also made to interest the trackmen. However, to drive home the lesson, a count was made of the ties that it was agreed should be removed. This was compared with the number of ties that the foreman and roadmaster had recommended for

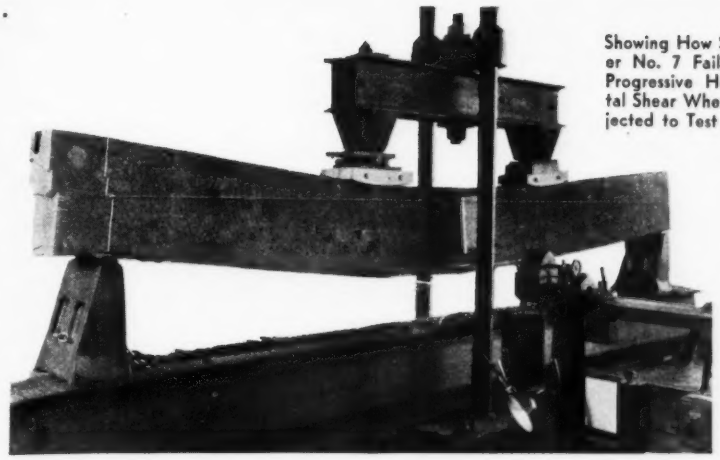


This Tie Stays in—Crossing Off the Foreman's Mark

renewal in the mile, and the number of ties requested for the entire section was cut in the same proportion.

In the main, however, the primary effort has been to educate the foremen. In addition to talking to them on the track, we hold foremen's meetings—56 of them in one year. In all these talks and conversations, every effort is made to drive home lessons in economy in the use of material. Particular pains are taken to show how much money is wasted by the removal of ties that should have been left in the track, and to make this still clearer we generally put this in terms of wages or man-days. That this point is readily driven home is illustrated by an experience I had in Arkansas when I visited a section a year after an earlier visit during which I had

(Continued on page 431)



Showing How Stringer No. 7 Failed by Progressive Horizontal Shear When Subjected to Test No. 2

By J. A. NEWLIN
and
GEORGE E. HECK*

Tests Show Strength of Douglas Fir Stringers After 23 Years Service

Investigation conducted at U. S. Forest Products Laboratory developed interesting facts concerning untreated timbers removed from trestles of Chicago, Milwaukee, St. Paul & Pacific after 23 years service. Data obtained point to the importance of certain items of inspection routine in determining when a stringer must be taken from service.

TO WHAT extent are bridge timbers safe for reuse after their removal from old structures? What is the influence on the strength of such timbers of visible defects, such as decay and checks developed in service? What changes, if any, take place in the properties of normal clear wood after many years' service? The determination of answers to these questions was the chief object of tests conducted recently at the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, at Madison, Wis., in co-operation with the Chicago, Milwaukee, St. Paul & Pacific. An account of the manner of conducting the tests, together with the results obtained, are given below.

The members tested consisted of 10 Douglas fir bridge stringers selected at random from a quantity of timbers removed from trestle bridges in branch lines of the C. M. St. P. & P. northwest and southwest of Mobridge, S. D. The timbers had been in service 23 years, or since the lines were built in 1910, and were obtained originally from the Grays Harbor district in Washington.

The stringers were all rough sawn, full size, and practically all heart wood, measuring approximately 8 in. by 18 in. in cross section and 30 to 32 ft. in length. Three of the stringers (Nos. 5, 6, and 10) were boxed heart, but only No. 10 had the pith near the center, resulting in characteristic deep wide checks. The remaining seven stringers were side cut, or cut approximately through the pith. Seasoning checks in these stringers were very fine, apparently having become closed during the drying out of the centers of the timbers in service. A varying amount of decay was noted on the top faces of all stringers, principally where ties had contacted.

Before making the tests each stringer was carefully graded for defects on all faces, the percentage grades of the various timbers (based on knot sizes only) being given in the table. The difference between these values and 100 represents the percentage reduction in strength that can be expected owing to the knots present.

The depth of checks and shakes appearing in the middle half of the two wide faces of each timber was estimated by probing with a pointed piece of steel 0.015 in. by ⅜ in. in size. The accuracy of this determination of the checked area in beams failing by horizontal shear was determined after testing the piece by splitting it open along the plane of shear. The actual depth of the check or shake was then readily determined by noting the stained condition of the sides of the opening.

Two static bending tests were made on each stringer whenever possible. First a bending test, or Test No. 1, was made over a 19-ft. span at one end of each stringer with two load points 30 in. apart, symmetrically placed with respect to the center of the span. The stringer overhung one support 6 in. and the other support from 10½ to 12½ ft., depending on its length.

The second bending test on the same stringer, or Test No. 2, was made on a 16-ft. length cut from the end that overhung the support in Test No. 1. In this test a 15-ft. span and ⅓-point loading was used, according to the standard practice for new timbers. In addition, compression tests parallel to the grain were made on full-sized sections 24 in. long, in which the maximum load only was obtained, while compression tests perpendicular to the grain were made on sections 30 in. long.

After the tests described above had been completed, small clear specimens cut from the stringers were tested

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for static bending, compression parallel to the grain, compression perpendicular to the grain, impact bending, shear hardness, cleavage, and tension perpendicular to the grain.

The results of the tests on the stringers and brief notes on the failures are given in the accompanying table, together with the average results of the minor tests on the small clear specimens, these being listed in the table as results of Test No. 3. It will be noted from this table that only seven stringers were suitable for Test No. 2.

The major tests showed that the decay that was present where the ties had come in contact with the stringers, even when 3 or 4 in. deep, was not the primary cause of failure. Two stringers which had been bolted to the caps failed in the No. 1 tests by tension in the decayed section at the bolt holes. When subjected to the same test, two other stringers failed due to the presence of

Table Giving Complete Test Data for Each Stringer and Indicating Manner of Failure

Beam Number	Test Number	Grade	Static Bending: Fiber stress at Proport'l. Limit, lb. per sq. in.	Static Bending: Fiber stress at Proport'l. Limit, Ratio to Minors	Static Bending: Fiber stress at Maximum Load, lb. per sq. in.	Static Bending: Fiber stress at Maximum Load, Ratio to Minors	Modulus of Elasticity, 1,000 lb. per sq. in.	Modulus of Elasticity, Ratio to Minors	Defl'n. in ins. at Proport'l. Limit	Defl'n. in ins. at Maximum load	Cal. hor'l shear lb. per sq. in.	Comp. par'l. to grain: Maximum Crushing Strength, lb. per sq. in.	Comp. par'l. to grain: Maximum Crushing Strength, Ratio to Minors	Comp. perp'r. to grain: Fiber Stress at Prop'l Limit, lb. per sq. in.	Comp. perp'r. to grain: Fiber Stress at Prop'l Limit, Ratio to Minors	Principal Failure
1	1	79	2,735	.35	3,440	.31	1,466	.84	1.03	1.35	151	5,300	.73	526	.59	(Tension influenced by decay at vertical bolt holes. (Spike knot and compression failure at cap bearing.
	2	--	1,714	.22	3,085	.28	1,308	.74	.53	1.14	227	-----	---	---	---	Horizontal shear.
	3	--	7,780	1.00	11,150	1.00	1,755	1.00	----	-----	---	7,220	1.00	886	1.00	
2	1	61	1,740	.30	5,000	.61	1,165	.96	.82	3.50	222	4,510	.82	465	1.11	Horizontal shear in ring shake.
	2	--	-----	----	-----	----	-----	----	----	-----	---	-----	---	---	----	No test.
	3	--	5,740	1.00	8,210	1.00	1,214	1.00	----	-----	---	5,470	1.00	418	1.00	
3	1	72	3,810	.42	5,900	.47	1,850	.91	1.11	2.11	259	5,760	.69	460	.70	Horizontal shear.
	2	--	-----	----	-----	----	-----	----	----	----	---	-----	---	---	----	No test.
	3	--	9,160	1.00	12,580	1.00	2,033	1.00	----	-----	---	8,380	1.00	686	1.00	
4	1	81	3,350	.46	4,640	.44	1,550	1.01	1.20	2.04	206	4,570	.65	470	.82	Tension at spike knot.
	2	--	2,570	.36	4,555	.44	1,581	1.03	.64	1.27	332	-----	---	---	----	Horizontal shear.
	3	--	7,240	1.00	10,420	1.00	1,535	1.00	----	-----	---	7,040	1.00	570	1.00	
5	1	86	3,040	.35	7,600	.59	2,112	.97	.79	2.28	341	6,760	.81	650	.88	Horizontal shear through bolt hole.
	2	--	3,090	.35	4,915	.38	1,491	.68	.81	1.40	361	-----	---	---	----	Horizontal shear along growth ring.
	3	--	8,730	1.00	12,940	1.00	2,197	1.00	----	-----	---	8,390	1.00	741	1.00	
6	1	68	4,252	.60	6,020	.60	1,608	1.06	1.46	2.39	268	5,180	.83	698	1.09	Horizontal shear through bolt hole.
	2	--	-----	----	-----	----	-----	----	----	----	---	-----	---	---	----	No test.
	3	--	7,050	1.00	10,000	1.00	1,514	1.00	----	-----	---	6,220	1.00	638	1.00	
7	1	87	3,930	.61	5,560	.55	1,572	.96	1.01	2.24	242	4,680	.70	436	.89	Horizontal shear.
	2	--	3,040	.47	4,320	.43	1,661	1.01	.72	1.20	315	-----	---	---	----	Horizontal shear.
	3	--	6,470	1.00	10,150	1.00	1,641	1.00	----	-----	---	6,670	1.00	489	1.00	
8	1	57	2,322	.33	3,480	.34	1,119	.74	1.13	1.90	157	4,500	.73	694	.86	Tension at 3-inch knot (cull grade).
	2	--	2,645	.37	4,380	.42	1,292	.85	.79	1.39	326	-----	---	---	----	Horizontal shear through checks at bolt hole.
	3	--	7,120	1.00	10,300	1.00	1,522	1.00	----	-----	---	6,170	1.00	811	1.00	
9	1	83	2,780	.38	4,240	.40	1,734	1.01	.88	1.45	190	4,730	.66	509	.84	Horizontal shear along growth ring.
	2	--	-----	----	3,860	.36	-----	----	----	1.76	286	-----	---	---	----	(Horizontal shear followed by tension at knots - influenced by test No. 1).
	3	--	7,260	1.00	10,670	1.00	1,713	1.00	----	-----	---	7,170	1.00	605	1.00	
10	1	75	3,210	.37	4,805	.40	1,520	.75	1.14	1.76	218	4,630	.58	598	.94	Tension at decay in vertical bolt hole.
	2	--	-----	----	2,560	.21	-----	----	----	4.00	191	-----	---	---	----	(Horizontal shear followed by tension at knots - influenced by test No. 1).
	3	--	8,780	1.00	12,100	1.00	2,036	1.00	----	-----	---	7,970	1.00	639	1.00	

Note—In the second column No. 1 refers to original 32-ft. stringers tested over 19-ft. span and loaded at two points 30 in. apart. No. 2 refers to 16-ft. sections cut from 32-ft. stringers after test No. 1 and tested over a 15-ft. span—load at ⅓ points. No. 3 refers to minor tests on small clear specimens cut from stringers.

knots. The other six stringers tested on the 19-ft. span and all of the stringers tested on the 15-ft. span failed primarily by horizontal shear. The former gave an average shearing stress of 254 lb. per sq. in., based on the full cross section of the timber and calculated in the usual manner, while the lowest value was 190 and the highest 341 lb. per sq. in. Two of the timbers subjected to Test No. 2 were influenced by Test No. 1. The other five averaged 312 lb. per sq. in. in horizontal shear.

One of the striking features of the tests on both spans was the tendency for horizontal shear failure to take place through horizontal bolt holes near the lower edge of the timbers, which is not a point of high average bending or shear stress. Since these failures occurred only when the holes were near the edge it is suggested that, until further tests can be made, chord bolt holes in the future be placed not closer than four inches to the lower edges of the stringers.

It was evident from the minor tests that the properties of the clear wood, when uninfluenced by shakes, checks, or decay, were not affected by the 23 years of service which the timbers had undergone.

The results of these tests appear to justify the following recommendations:

1. Stringers that have been removed from bridges should not be reused in such a manner as to place a portion that has been over the caps out in the new span.

2. With proper inspection, most of the timbers that are now in service in bridges on the branch lines from which the test specimens were obtained, and are of the same age as the timbers tested, could be left in service. This inspection should include:

(a) Inspection of the bearings to see that the timbers are not mashing excessively at these points.

(b) Inspection of the lower edges of the timbers to see that no excessively large knots are present in the middle half of the span.

(c) Horizontal shear: (1) It does not appear feasible to determine the extent of shakes and checks by means of a probe. (2) Tests for horizontal shear failures can be made by loading the bridge and observing possible shear distortions. We believe this can be done by marking vertical lines near the supports on the outside members of each chord when the bridge is not loaded, and then running a heavy concentrated load, such as the truck of a loaded car, approximately to the center of the span and noting any breaks in the vertical lines due to shear distortion.

All timbers showing excessive mashing at the bearings, knots more than two inches in diameter on or near the lower face in timbers of the size tested, and failure by horizontal shear should be removed.

The Author at Work Repairing a Frog

Your Welding— Are You Getting the Most From It?

Many "tricks of the trade" in building up and repairing switch points, frogs and rail ends are practiced at the Proviso yard of the North Western

By CHARLES WISE*

WELDING as a means of effecting economies in the use of track materials is a practice that has gained wide application among the railroads of this country during the last few years, although there are as yet many roads that have not taken full advantage of the opportunities for effecting the savings that are offered by the oxy-acetylene welding process. The purpose of this article is to describe the practices that have been in use at the Proviso yard of the Chicago & North Western, with the thought that through it other railroads will be enabled to make more efficient and effective use of their welding outfits.

Welding Switch Points

In building up switch points, the factor of most importance is to avoid building the point too high, as points that are higher than the stock rail soon begin to break off along the top. Another common condition that causes either new or welded switch points to break is the presence of a lip on the side of the ball of the stock rail, which prevents the point from fitting properly against the rail. As a consequence, when wheels pass over the switch only the top part of the point is supported against the stock rail, a condition that soon causes the point to break.

The welder should first trim off the lip as far along the rail as is necessary to enable the point to fit properly against the rail. The quickest way to do this is to use the cutting torch and if the resulting cut is too rough it can be smoothed by heating the ball of the rail and using a flatter. In cutting off the lip, care should be taken not to cut into the ball of the rail any more than is necessary. Aside from the torch, there are other tools on the market which can be used for trimming off the lip, one of the best of which is the portable grinder.

When welding a switch point to build it up, an effort should be made to avoid getting the metal too hard. The flame must be properly adjusted and the hot metal should be hammered vigorously, as this has a tendency to toughen it. A rod of softer steel should be used for the last six inches of the switch point in order to obtain the proper degree of toughness. This soft metal should be applied to the rail in a thin coating and hammered. This coating should in turn be covered with metal from the rod that is used regularly in this work. In this way the two metals will mix, resulting in a product that will be tough, but not hard enough to break easily.

Straightening Warped Switch Points

The welding of switch points has a tendency to warp the switch rail, causing the end to turn up, this tendency increasing with the length heated. This defect may be overcome by putting two or three "hot spots" on the base after the point has been allowed to cool. At each of the points where this is done about six inches of the base of the rail on both sides of the web is heated to a dark red. It is best not to make more than three of these spots, spacing them about two feet apart, measured from the first spot toward the switch point. While the base of the rail is being heated, it will appear that the end is becoming warped more than before but upon cooling it will be found that the point has dropped to the normal position.

We weld switch points both in and out of the track. In out-of-track welding the point should be arranged the same as if it were in the track, it being preferable to use a rail on which the ball is worn down to some extent. With this precaution the welder is not so likely to build the point up too high.

Some of the rail grinders that are now on the market are of considerable help in switch-point work. With these grinders, it is an easy matter to grind the point to the desired height and otherwise to finish it better than is possible with the usual tools.

In building up rail ends by welding, one of the most common mistakes is to renew or reverse the angle bars after the rail ends have been built up, rather than before. Likewise, where the joint is too low it should be tamped up before proceeding with the welding.

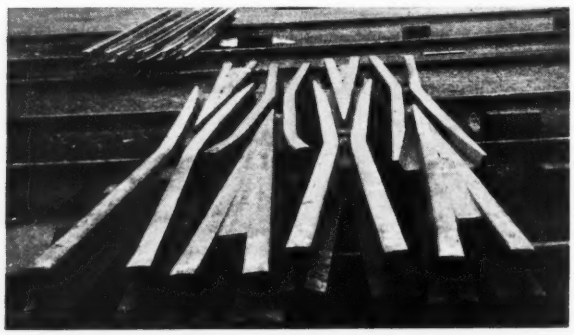
*Mr. Wise handles the track welding work at the Proviso (Ill.) yard of the Chicago & North Western.

Where new angle bars are applied or the joints are tamped up after building up the rail ends, it will be found that the rail ends are too high. The reason for this is that when the bars are replaced, the new bars raise the rail ends slightly in addition to the amount they were raised by welding. In such a case less welding would have been required if the bars had been renewed first, thereby reducing the cost of welding.

I have found that there is little likelihood that modern, heavy heat-treated angle bars will be affected adversely by the heat produced by the welding process. This is prevented by the fact that most of the heat is dissipated because of the relatively large radiating surface through the rail and the bar. In fact, some railways are crowning and straightening worn angle bars with the acetylene torch.

Welder Should Not Hurry

It has been my observation during the past year or two that there has been a tendency to obtain too much speed in welding, particularly in the building up of joints. I have seen hundreds of joints that have failed because the welder tried to put the metal on too fast. Others have failed because a new man on the grinding



Four Frogs That Have Been Repaired by Welding

machine was required to do the work faster than he was capable of doing it properly. There is such a large saving to be gained by the proper use of the welding process that, in my opinion, it is better to obtain a high quality of work at a slightly higher cost, than to spend less and obtain work that will not be satisfactory.

Extra Care Used with Self-Guarded Frogs

In order to weld the guard rails of self-guarded frogs successfully, this work should be done with extra care. Where possible, the frog should be removed from the track, but where this is not practicable every effort should be made to avoid the use of the frog while the guard rail is being welded. There is danger of a derailment if a train passes before an opportunity is had to put a long run-off on the weld. In rebuilding the worn guard rail, the calipers should be set to the same thickness as the original rail. When the rail cools it will then be found that the thickness of the rebuilt portion is slightly less than the original, but this is very desirable as derailments have occurred because the guard rail had been built up too full and the run-off was not long enough. In this connection it is very important to make a long run-off that tapers gradually.

In building up guard rails of self-guarded frogs it is a good idea to use an excess of acetylene, as this will produce a metal that is sufficiently hard to withstand the abrasive wear to which it is subjected. In other respects, the procedure is the same as on the remainder of the frog, except that the welder should have had some experience on side welding before attempting to weld one of these guard rails.

Reclaiming Bent and Broken Frogs

Wing rails or points of frogs frequently become broken and in other cases frog rails are bent as the result of derailments. It has been our experience that such frogs can be repaired and replaced in track practically as good as new. When a frog is brought to the shop with a broken point, we take it apart in order to get both pieces of the broken rail. Then the edges of the break are formed so that when the pieces are welded together they will make a V. When welding the two pieces together, the base is welded first, then the web and finally the ball. A mild steel rod is used for the base and the web and for about one-third of the ball, which is finished with the same rod as is ordinarily used in frog work.

Where the wing rails of a frog are bent outward, we insert a long bolt through the bolt holes at the end of the rail and heat the base of the rail where it is bent, so that when the nut on the bolt is tightened the rail will return to its proper position. When bending a rail in this manner it should be bent a little farther than is apparently necessary, since the rail will have a tendency to bend outward slightly as it cools. Where rails are bent inward, we use a small but powerful screw jack which we put between the rails to force them apart after they have been heated as described above. Bent switch points can be straightened by using a standard rail bender and heating the base in the same manner as for frog rails.

Advises Butt-Welding Rails on Bridges

The butt welding of rails through highway crossings, station platforms and at terminals is saving the railroads considerable money, which was formerly spent on the upkeep of the joints at these places. Not many roads, however, are as yet butt welding rails on bridges. This practice could well receive wider application as it would result in a reduction in the cost of upkeep on the bridges.

Most of the frog and switch point welding in the Proviso yard is done in a small centrally-located shop. However, in recent months we have found that it is more economical to weld a greater proportion of the frogs in the track than was formerly the practice. Welding the frog in the track saves the cost of handling it, although in places where we cannot get at least one frog or five switch points to weld per day, we have the frog or the points taken out of the track and welded at the shop.

Grinder Is Important Development

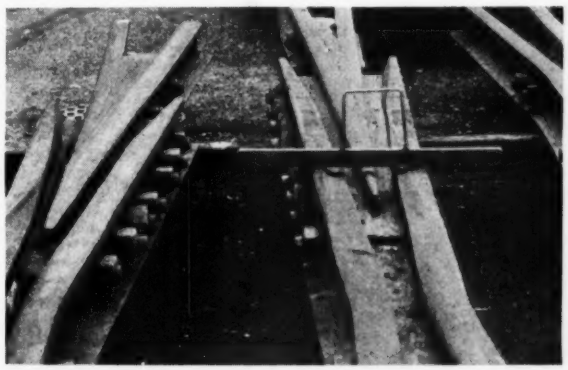
One of the most important developments that has been made in recent years in the building up of rail ends by welding is the introduction of the rail grinder for finishing off the weld. Grinders are especially useful on welds that measure more than four inches in length. It is rather difficult to get a smooth surface on a long weld with the flatter as such welds must be applied in several patches. However, it is a comparatively simple matter to obtain a perfect surface with a rail grinder. The important thing is that the use of the grinder has increased the output of the welding gang,

which means cheaper and better built up rail ends.

The use of the oxy-acetylene cutting torch can effect a large saving in the cost of cutting rails where a welding outfit is at hand, especially in these days when rails are used so long as it is possible to obtain a usable piece from them. One of the advantages of the use of the cutting torch is that rails can be cut without the necessity of removing them from the track. Another is that the cut can be made close to the end of the rail, which is not always possible when other methods are used. Furthermore, the safest way to cut a rail is by using the cutting torch, for there is then no danger of personal injury from flying steel. In addition it takes about 1½ min. to cut a rail with the torch, which is faster than this can be done by any other method. Some maintenance of way men contend that cutting the rail with a torch will cause it to break. I have cut thousands of rails by this method and have yet to see one of them break where the failure could be traced even remotely to the method of cutting.

Programming Welding Work

We have so planned our welding operations that the welding outfit commences in the spring of the year on one of the outlying sections and does all of the welding that can be done most economically in track. The yard is divided into 11 sections and when we finish



The Shadow Cast by the Straight Edge Indicates the Extent of the Wear on this Frog

the welding on one section we move to the next, and so on, until we have covered the entire yard. This outdoor work, which requires about seven months to complete, is done during the milder seasons of the year. During the winter we do work in the shop that could not for any reason be done in the track during the previous summer.

Day-to-Day Orders Not Advisable

It is good practice to plan welding operations in advance, thereby saving much time which otherwise would be required to move here and there.

In general, it has been my experience that it is not good practice for the roadmaster or supervisor to give day-to-day instructions to welders, particularly in large yards. If this is done, the welder, having completed any job that he has been told to do, will wait for further orders instead of proceeding with work that he knows should be done. A welder should be given a specified territory to cover and be held responsible for keeping all welding work up to date. Under this system more work will be accomplished in less time and at considerably less expense.

When Should a Tie Come Out?

(Continued from page 426)

talked at some length on the money lost by taking out good ties. As I walked along the track toward the foreman, I passed two negro trackmen and overheard the following conversation:

"Who's dat man?"

"Ah don' know his name; but ain' he de man dat done tol' us dat ev'y time we take out foah ties dat didn' half to come out, three men gwine half to be laid off?"

Judging from the description and from the photographs, this type of tie inspection may seem to be unduly expensive. As a matter of fact, the expense for track labor chargeable to it on the Rock Island is about $35,000 per year. It is possible for a foreman and two men to inspect about three miles of track a day, but we are also instructing our men to make close inspection of spikes, plates, angle bars and outside base of rail at the same time. Of course the check inspections take considerable of the time of the division officers who accompany me over their tracks, but I am sure that they feel that this time is well spent. Moreover, beginning with the spring of 1934, I limited my examination on each section to 10 poles in locations where the renewals are the heaviest and later reduced it to 5 poles. This progressive curtailment of the check inspection is warranted by the progress made by the track forces in putting the plan into practice themselves. Thus, in this year's inspection, we graded the foremen on their proficiency in selecting the ties for renewal, and the result on 419 sections, expressed in percentages of a perfect score, is as follows:

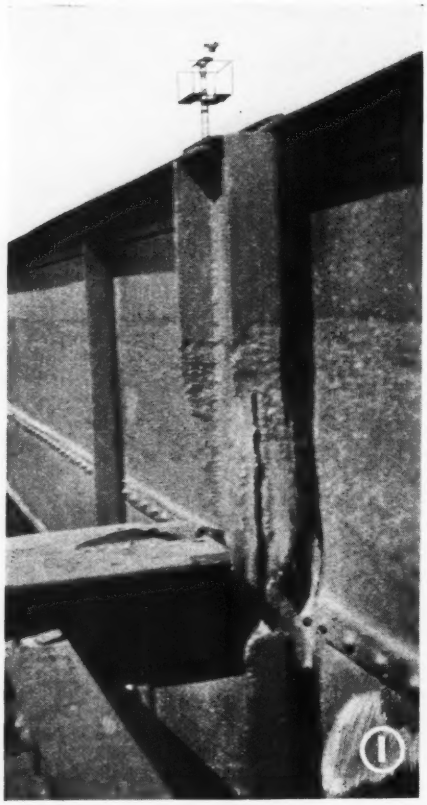
313 foremen—95 to 100 per cent
13 foremen—85 to 95 per cent
30 foremen—75 to 85 per cent
63 foremen—less than 75 per cent

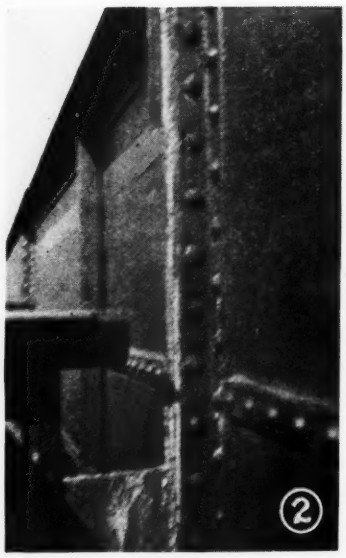
It is to be expected that any plan as radical as this will meet with some opposition. In a few cases, we have had to bear down pretty hard to get men to see that we are not trying to do their work for them. There was a difference also in the readiness with which the men grasped the method; in general, it may be said that the men with the least experience learn to apply it most quickly, for they have no preconceived ideas.

One of the most important factors in putting this plan into practice was to put over the idea that, once having been convinced that the roadmasters and foremen understood the plan and were applying it accurately, we would give them all the ties they asked for. We went even further than that. We said that we preferred that, in making the fall check for next year's renewals, they request only as many ties as are needed for the renewals, indicated by a strict application of the system rather than overestimate their needs, and we have set up a reserve supply from which we furnish additional ties to take care of any that fail between inspection and renewal.

Reference is made above to the cost of our method of checking tie renewal requirements. But to demonstrate that this expenditure has paid a return, it is only necessary to cite the savings that have been effected in the annual expenditures for the renewals. In 1930 the cost of tie renewals, track, switch and bridge (material only), on the Rock Island amounted to $1,845,053. In 1931 they were reduced to $1,433,991 and in 1932 and 1933 they totaled $554,344 and $706,332, respectively. However, in spite of the marked reductions in outlay for ties, we are convinced that our tracks are just as safe today as they were in 1930 and all tracks are really more uniformly tied up.

Electric-Arc W
Saves 40- Y





DEMONSTRATING the practicability of applying electric-arc welding to the making of major repairs to bridges and to strengthening them, as well as the economies that can be effected by this method, the Chicago, Burlington & Quincy has recently completed the rehabilitation of the O-Street viaduct at Lincoln, Neb., which crosses the tracks of this company and the Union Pacific. This structure, which is 1,752 ft. long and which carries heavy street and highway traffic, was erected more than 40 years ago. In addition to a marked increase in the volume of street traffic and in the weight and loading of the individual vehicles, the cumulative effect of more than 40 years corrosive attack by locomotive gases and roadway drainage, although the structure had been well maintained, had so reduced the effective sections of many of the members that the viaduct was no longer able to carry the increased loading which was being imposed upon it.

Study Showed Advantage of Repair Project

Since this viaduct affords the only means of access to the business district of Lincoln, except by resorting to a long roundabout detour, for a large and important territory to the west of the tracks, besides affording the only practicable access to the city from a heavily traveled highway, it was neither practicable to close the structure permanently, nor to restrict the weight of the vehicles using it. On the other hand, owing to sharply reduced earnings, the railways were reluctant to undertake the expenditure necessary to replace the viaduct. After a thorough study of the details, both in the field and on the plans, it was decided that satisfactory repairs could be made and that certain members could be strengthened by electric-arc welding, which would restore the structure to good condition and permit it to carry the increased loading, thus extending its service life for many years. It was also estimated that this could be done at approximately one-third of the cost of a new structure, thus eliminating the far greater cost that would have been necessary for replacement.

Character of Structure

This viaduct, which is located immediately south of the Burlington passenger station, carries O street across the tracks of the two railways mentioned. It comprises 36 spans, varying from 8 to 133 ft. in length. Beginning on the east, there are 19 half-through plate-girder spans ranging from 37 to 50 ft. in length; 2 through trusses, each 133 ft. long; 9 spans ranging from 29 to 69 ft. long, of which 6 are of the half-through plate-girder type and 3 are I-beam spans; 1 through truss of 101-ft. span over the former channel of Salt creek, now abandoned; 4 spans ranging from 21 to 50 ft. long, including 1 I-beam span; and 1 I-beam span of 8 ft. The roadway has a clear width of 25 ft. 3 in., while two 4-ft. sidewalks are supported by cantilever brackets on the outside of the girders and trusses.

The superstructure is supported on steel bents, except at four points where heavy stone-masonry piers are used, three of these being under the 133-ft. through-truss spans and the fourth at the west end of the sixth span from the east, where the east approach grade intersects the level grade on the bridge. The columns of the steel bents are built-up sections of four Z-bars and a web plate, as shown in one of the drawings, and at the fixed ends of the span extend up to the top of the girders, the ends of the girders being framed into the columns. The end floor beams at both the fixed and expansion ends are independent of the girders, being attached to the columns by means of diaphragms which extend through the columns and afford the means also of attaching the sidewalk brackets. Elsewhere these brackets are attached di-

Welding Year-Old Viaduct

This article deals with the manner in which the electric-arc process was employed in strengthening and repairing an old structure at relatively low cost. A number of special problems were imposed in correcting defects resulting from faulty details in the old design.

rectly to the girders or at the panel points of the trusses.

As originally constructed, the webs of the plate girders were not provided with intermediate stiffener angles. For spans up to 47 ft., only one intermediate floor beam was used; in longer spans there are two. This arrangement left, therefore, panel lengths between gussets ranging from 16 to 23 ft., in which no provision was made for stiffening the web against buckling, except for the relatively small resistance offered by a shelf angle placed at the level of the top of the stringers to support the ends of the transverse deck timbers. As the section of this shelf angle was reduced by corrosion, the resistance which it offered to the buckling of the web plates was reduced accordingly.

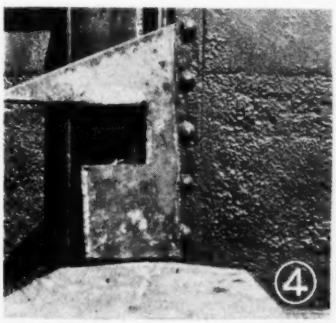
ing surface of 4-in. wood paving blocks was laid on this course. In recent years, however, as the wood block paving had worn, it had been overlaid with a wearing surface of asphalt.

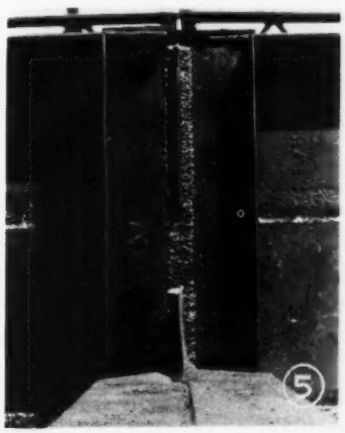
This deck, including the guard rail, was laid tightly against the web of the plate girders, with no provision for ventilation. This construction tended to trap locomotive gases below the deck, and as they dissipated slowly, a considerable volume of the gas was able to work up through the crevice between the deck structure and the girder.

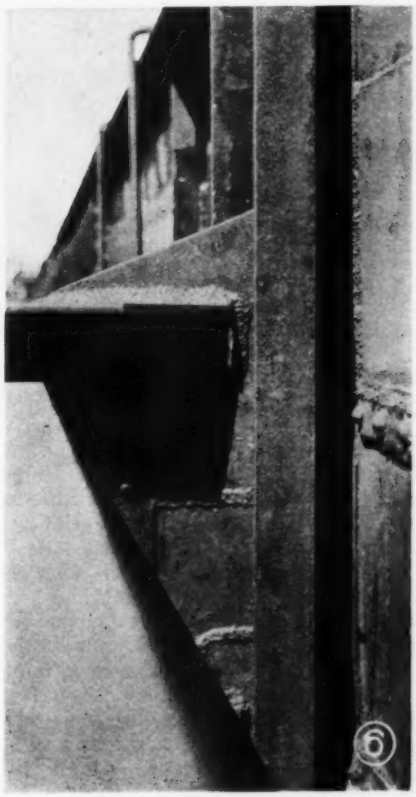
When rain fell or water ran over from the roadway surface, it also seeped into this opening and evaporated slowly owing to the lack of free ventilation, in the meantime absorbing part of the corrosive gases. These conditions tended to accelerate corrosion, particularly along the strip covered by the decking and guard rail and immediately above and below it, as well as at the ends of the floor beams.

Viaduct No Longer Adequate

By 1931, both the volume of traffic and the loading of individual vehicles had increased over the design loading to such a degree that it became apparent that the viaduct was no longer fully adequate for the service it was required to render. In addition, the reduction of many of the sections as a result of corrosion made the situation







Illustrations (1) to (6) Show Successive Steps in the Repair of a Floor-Beam Connection. See Text on Page 435 for an Account of the Procedure

From time to time in recent years repairs had been made to the viaduct as necessity arose and a few of the weak members of the floor system had been strengthened in an effort to keep pace with the increased loading and larger volume of traffic. As part of this work, stiffener angles had been added to the girders at various times as sections of the timber deck were renewed. Although it had been necessary to renew the highway deck at various times, the original construction had always been followed in making these replacements. This consisted of a course of 4-in. by 10-in. untreated timbers (which were replaced in 1909 with creosoted Douglas fir) placed transversely on the stringers and shelf angles. Over this, unmatched fir plank, 2 in. thick, was laid longitudinally. The wear-

still more acute. A thorough inspection of the structure at this time confirmed the belief that it would be inadvisable to continue it in service, unless work of a major character, including both repairs and strengthening, was to be done upon it.

Work Divided Into Two Parts

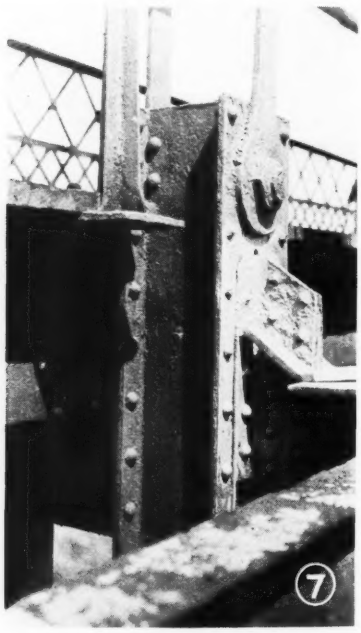
This inspection also disclosed that the roadway deck was not in need of immediate renewal and that a considerable part of the work could be done without disturbing the deck. It was decided, therefore, to divide the work into two parts, completing such items in 1931 as could be done without interfering with the use of the roadway, and to defer the remainder, thus obtaining advantage of the additional life of the roadway deck.

One of the serious defects of the structure was the lateral movement of the girder spans under load, particularly when vehicles were moving at speed. When it was constructed, there had been little need to provide for lateral stiffness under the lighter and slow-moving loads of that day. For this reason, reliance had been placed entirely on the stiffening effect of the floor deck and the sway bracing of the steel bents, except that lateral rods had been introduced in a few of the longer spans.

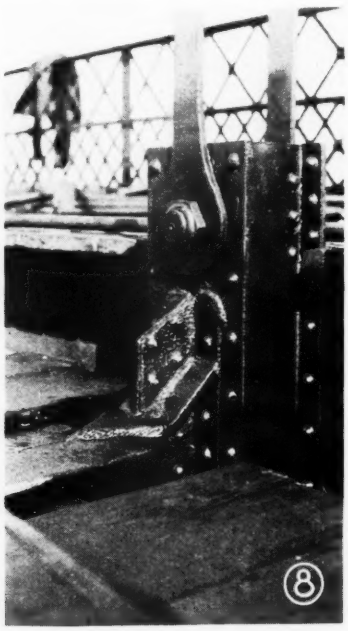
To overcome this defect, the work done in 1931 included the placing of 1,575 diaphragms between stringers to stiffen the floor system. As a further measure to effect lateral rigidity of the structure as a whole, the existing sway bracing in the steel bents was replaced with heavier and stiffer members. Among other parts of the structure, the floor beams were too light and the plans contemplated the strengthening of these members by the addition of bottom cover plates and the replacement of the top flange angles with heavier sections. Since the latter could not be done until the floor was removed, the replacement of the angles was deferred, but the cover plates were installed in 1931. Similarly, it was considered necessary to strengthen the girders, and this was done in 1931 by the addition of top and bottom cover plates. In renewing the top flange angles of the floor beams, heavier sections were selected than were required to withstand the load stresses, angles having an additional thickness of ⅛-in. being used to allow for corrosion, since the deck construction makes it impracticable to clean and paint them except when the deck is removed.

Organization and Equipment Carefully Considered

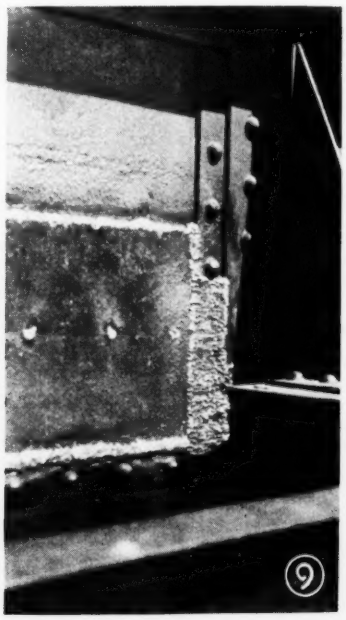
The second part of the schedule was started early in 1933. Careful attention was given to the organization and equipment to insure the best results in economy and time, as well as to provide for the proper sequence and maintain a balance between the various parts of the work. The first operation was the removal of the floor. The gang that did this also replaced the deck after the steel work was completed and painted, and also handled the material to the point of use as needed. Following the removal of the deck, two men with acetylene torches cut off the outstanding leg of the shelf angle.



Floor-Beam Connection to a Truss Cleaned Ready for Welding



A View of the Same Connection After the Work Was Completed



Girder Webs Were Reinforced by Welding on a Plate

During this time four air compressors had been set up, including two 250, one 110 and one 160 cu. ft. capacity units, to furnish air for sandblasting, knocking out rivets, riveting, spray painting and boring the deck timbers. As soon as the shelf angle was cut and the torches were far enough in advance, the inner faces of the girders, the tops of the stringers, all connections and other surfaces having loose paint or scale were sandblasted to provide sound metal with clean surfaces for the succeeding operation.

Following the sandblasting, the cutting torches were returned to cut out all steel that was marked for removal. This included the top flange angles of all floor beams and the badly corroded parts of the web at the ends of these beams. The Z-bars comprising the posts were cut out as far down the columns as was necessary to reach a point of full section. Many of the stiffener angles on the girders were badly corroded where they had been covered by the deck. These sections were cut out. There were others, however, that had been installed so short a time that they were little affected. Occasional rivets were cut out and replaced with new rivets. In

general, however, this replacement was made by welding new metal in the old rivet holes, thus automatically overcoming any irregularities in the size or shape of the holes caused by wear.

In the meantime, four portable electric generators were set up, three of which were electrically driven and the other gas driven. This equipment had sufficient generating capacity to serve four welding gangs, some of the units serving two shifts. The four welders were assisted by properly qualified helpers as became necessary, these men being assigned to the operation as a whole rather than to the individual welders.

A tractor and several trailers were assigned to transport the material required by the welders and that for replacing the deck. All new material was held in cars until needed, when it was raised to the deck by means of an air hoist which also placed it on the trailer that was to deliver it to the point of use.

In replacing the sections of the stiffener angles that were cut out, the ends of the inserted pieces were welded to the old angles, but the new sections were riveted to the girders to preserve a uniform appearance. Similarly, a number of new stiffeners were added, and for the same reason were riveted. In replacing the top flange angles of the floor beams, it was considered preferable to rivet them, as this could be done at substantially the same cost as welding. Furthermore, the replacement of these angles was a major item in the schedule, which consumed a large amount of time. Since the riveting could be carried on simultaneously with the welding of the other members and without interfering with it, the welders were released for the work for which welding was better adapted and the time necessary to keep the viaduct out of service was shortened proportionately. In this connection, one floor beam was renewed for the purpose of improving the riding qualities of the vertical curve at the intersection of the east approach grade and the level grade on the bridge.

Repairing Floor-Beam Connections An Involved Operation

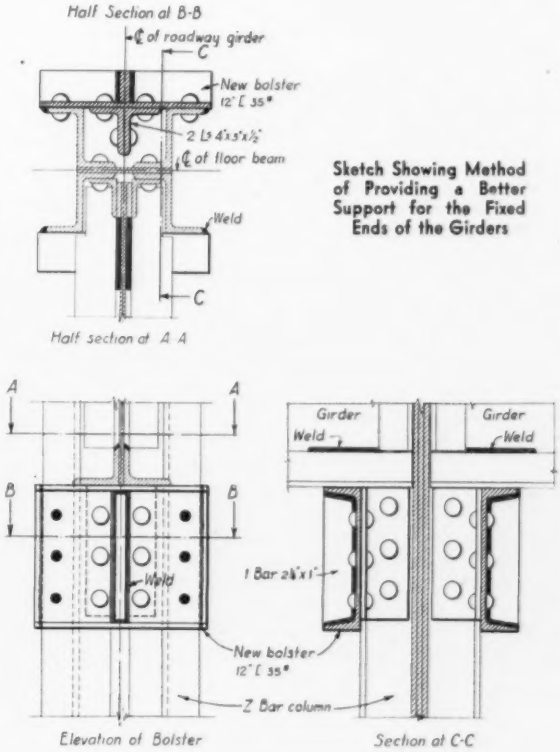
In general, the connections of the end floor beams and of the girders at their fixed ends were the points of greatest weakness with respect to details, while the ends of these floor beams and their connections had suffered more severely from corrosion than other parts of the structure. Again, because of the unusual design of the supporting columns, the details of repairing and strengthening these connections were somewhat more involved than elsewhere in the structure.

By reference to the accompanying drawings, the construction of the columns and the method of connecting the floor beams and girders will be readily understood. The accompanying photographs, Figs. 1 to 6, inclusive, are all views of the same connection, which show the sequence followed in restoring the floor-beam connection. Figure 1 shows the condition of the upper part of the columns and the end of the floor beam as they were uncovered by the removal of the deck. It will be noted that the web and one leg of the Z-bars and that part of the gusset plate above the floor beam have been destroyed by corrosion. In Fig. 2, the sandblasting has been completed and the damaged metal cut away.

At the stage shown in Fig. 3, the top flange angles of the floor beam had been renewed and one flange and the web of a new Z-bar, from which one flange had been cut off, had been welded in place. This view and the one following also give an idea of the corrosion induced in the web of the girders by the locomotive gases and moisture. Figure 4 is presented to show the shape and amount of metal required to restore the gusset. It will be noted that while the plate is intended to act also in part as a knee brace, it is cut so that it does not come above the level of the deck. Figure 5 was taken after the second Z-bar and the gusset had been welded on, and Fig. 6 is a side view of the completed work. Figures 7 and 8 illustrate similar repairs to a floor-beam connection on one of the through truss spans.

Floor Beams and Girders Given Additional Support

Although the work illustrated by the photographs restored the damaged sections, the connections between the floor beams and the columns still had insufficient strength to carry the present traffic. To strengthen this detail, brackets were added to the columns below the floor beams to give the needed support. Reference to the drawing will indicate the manner in which this was done, the heavy lines indicating the new work. Likewise



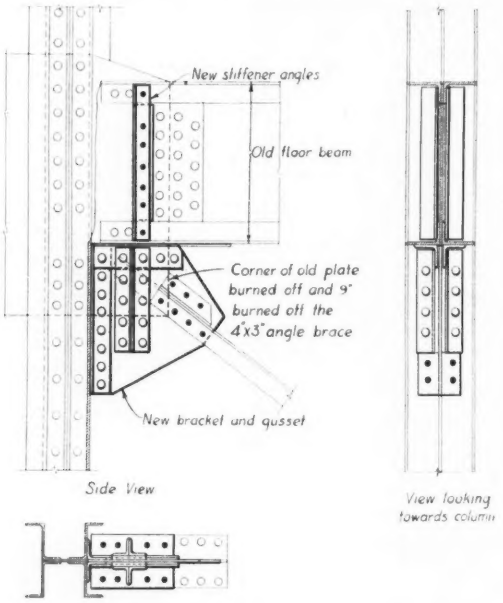
Sketch Showing Method of Providing a Better Support for the Fixed Ends of the Girders

additional support was needed to give greater strength to the connections between the fixed ends of the girders and the columns. The construction of the columns and the details of the existing connections were such, however, that this could not be done in the ordinary way by the addition of angles, plates and rivets.

This difficulty was overcome by designing bolsters which were applied to the columns under the ends of the girders, giving, in effect, brackets for them to rest on. As shown in one of the drawings, these bolsters were constructed of 12-in., 35-lb., channels, each 15 in. long, so placed that the girder rests on one of the flanges of the channel. To better resist this load, they were reinforced by two angles applied vertically to the back side of the web and by a plate 1 in. thick which was set between the flanges and fillet welded along all edges in contact. Both the angles and vertical plate come directly under the center line of the girders.

While there were many small details that required attention, three of major importance remain to be men-

tioned. The intermediate floor-beam connections in the girder spans did not originally include knee braces, and these were added at all such connections as part of the general improvement, to provide increased lateral support for the top flange. One of these is shown at the right in Fig. 9. Considerable reduction in section had also occurred to the floor-beam connections above the level of the floor beams in the through trusses. Not enough damage had occurred below the top of the beams, however, to require any action. To avoid the expense that would have been involved in cutting out and replacing the entire connection, or that part that was badly corroded, it was decided to restore the eroded section by


New stiffener angles
Old floor beam
Corner of old plate burned off and 9" burned off the 4"x3" angle brace
New bracket and gusset
Side View
View looking towards column
Bottom View

Method of Improving Connection of End Floor Beams to Columns

the addition of welded metal. Figure 7 shows one of these connections cleaned and ready for welding. To give added strength, a plate ⅜ in. thick was bent and split to fit over the legs of the connection angles and welded in place. Figure 8 shows the completed work.

Girder Webs Reinforced

As already mentioned, there had been a serious reduction in the thickness of the web of the girders within the area covered by the deck. To restore and reinforce these members, plates 15 in. wide, ¼ in. thick and of whatever length necessary were welded to the web plates. These plates were cut to the proper length to fit the panels between stiffener angles, none of them extending through the stiffeners. In placing them, they were first clamped in position and tacked along the middle line of the plates by means of ¾-in. holes drilled through the new plates only, and filled with welded metal. After the tack welding was completed, they were welded along the edges. The end of one of these plates is shown in Fig. 9. As soon as a span was completed the metal was painted, the usual bridge paint applied by means of a spray gun being used below the roadway level of the deck. To provide a reflecting surface that will have a high degree of visibility at night as well as by day, all parts of the structure above the level of the roadway were painted with aluminum paint.

To avoid a repetition of the conditions leading to the severe corrosive action induced by the original deck construction, the new deck was designed to afford free ventilation, a space of about six inches being left between the outer edges of the deck and the girders. Other than this, the new deck does not depart fundamentally from the old one. It consists of a course of 4-in. by 12-in. creosoted Douglas fir placed transversely, upon which 2-in., shiplap Douglas fir treated with zinc-meta-arsenite is laid longitudinally, the Z-M-A treatment being used to avoid the softening of the asphalt plank which would have occurred if it had been laid in contact with a creosoted surface. The wood block paving is omitted and asphalt plank 1½ in. thick provides the wearing surface. In placing the asphalt plank, it was desired to lay it as tightly as practicable in order to minimize the tendency of the corners to shear or wear round and of the plank to spread under load. To accomplish this, as each plank was brought to position, it was forced against the one previously laid by means of a specially designed jack. As it was pressed to a tight fit, nails were set with a hand hammer and driven home with an air hammer.

Since the new deck has no lateral support against the girders, to avoid the probability of lateral movement, specially designed anchor plates were placed at intervals in each panel to hold it rigidly in place. This consists of a plate split to fit over the flange of the stringers, from which it extends up the side of the four-inch floor timbers, to which it is secured by heavy wire spikes.

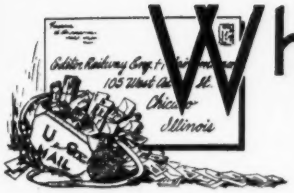
The project was planned and carried out under the direction of F. T. Darrow, assistant chief engineer, Lines West, and G. A. Haggander, bridge engineer of the Burlington. W. G. McDonald, supervisor of bridges and buildings, Lines West, was directly in charge of the field work in connection with the project.

Washout at End of Cut Causes Fatal Derailment

A WASHOUT was responsible for the derailment of a freight train of the Chicago, St. Paul, Minneapolis & Omaha that resulted in the death of three train service employees. The following account of this accident, which occurred 1.4 miles west of Northline, Wis., at 2:45 a.m. on April 3, was abstracted from the report of the Bureau of Safety of the Interstate Commerce Commission.

The derailment occurred on the westbound track of a double-track line that is on a grade of 1.286 per cent descending to the west. At the point of the accident, the line is supported against the side of a ridge of hills that rise on the south to a height of 100 ft. or more above the track. Just east of this place the line enters a cut and at a point about 450 ft. to the east, the south slope of the cut is broken by a gulley that drains a considerable area of the hillside into the south ditch of the cut. Following some trouble with the washing of sand into the ditch at that point, this gulley was riprapped last summer, but during a storm on the night of April 2 and 3, the rush of water down the gulley scoured out enough gravel and sand behind the riprap to block the south ditch, causing a flow over the tracks to the north ditch. This resulted in the deposit of sand on the tracks, while the heavy discharge in the north ditch undermined the westbound track at the end of the cut.

The section foreman at Northline had not patrolled his track during the storm, and by a coincidence, was called by the operator at about the time the accident occurred to examine the track at some point east of his headquarters, where water was reported flowing over the track by the crew of the train involved in the derailment.



What's the Answer?

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions that you may wish to have discussed.

To Be Answered in October

1. Where tie plates are fastened to the ties independently of the rail fastenings, should the lag screws be applied at the time the plates are installed or at a later date? Why? If the latter, what interval should elapse?

2. Under what conditions, if any, is it good practice to use treated timbers as bolsters, or blocking, under the shoes of steel spans to effect a raise in grade, provided this can be done without exceeding the strength of the timber across the grain? If so, what are the limitations? If not, what alternate method should be followed?

3. When renewing ballast, where two lifts are necessary, what interval should elapse between the first and final lifts? Why? What should be the maximum raise on the second lift? Why?

4. What are the relative advantages and disadvantages of lead and wrought iron or steel pipe in plumbing installations?

5. When inspecting ties for renewal, what tools should be used and in what way? Do the tools and the method of use differ for treated and untreated ties?

6. What precautions should be observed in placing outlet pipes through earth dams? Should the control valve be placed at the upper or lower end of the pipe? Why?

7. When laying rail, how far in advance of the various operations should materials such as bolts, spikes, tie plugs, tie plates, anti-creepers, etc., be distributed? What check can be kept on the distribution of these materials?

8. What methods should be employed and what precautions should be observed when pointing old stone masonry? What kind of mortar should be used? How should it be applied?

Renewing Switch Ties

Where only a part of the ties in a turnout require renewal, should the entire set or only the failing ties be replaced? Why? If the former, what disposition should be made of the sound ties that are recovered?

Would Not Renew the Full Set

By L. J. DRUMELLER
Division Engineer, Chesapeake & Ohio, Hinton, W. Va.

Where only part of the ties in a set require renewal, I do not consider that the whole set should be replaced, as this will involve a great deal of waste in the sound timbers remaining in the set, even though it may be the practice to reuse the salvaged ties in other turnouts or for other purposes. It will be found over a considerable number of years that where it is the practice to spot in switch ties for every year's renewal, in the same manner as is done with crossties, the set as a whole will be kept sound permanently. On the other hand, if the entire set is renewed, all of the ties should reach the end of their service life at practically the same time, which certainly would have a bad effect on switches in general, particularly through a period of depression such as the one we are now emerging from, where inability to get labor and material would mean deferred renewals of switch ties in general.

Where the full set is renewed at one time, the sound timbers that are recovered can be utilized for cribbing, as second-hand ties on remote and light-traffic branches or in temporary turnouts.

Replace Only Failing Ties

By J. H. GUEST
Roadmaster, Missouri-Kansas-Texas, Woodward, Okla.

Where only a part of the ties in a turnout require renewal, only such ties should be replaced. There is no better reason for replacing all of the ties in a turnout when some of them have failed than there is for replacing all of the crossties in a stretch of track to care for normal renewals. On the other hand, there is a distinct advantage in having the ties in a turnout fail a few at a time, the same as in ordinary track, instead of having a full complement of weak ties as the set approaches the end of its service life. By replacing a few bad ties every year a turnout can be maintained at uniform strength and safety at all times and the fullest possible service life can be obtained from every tie without taking a chance on having a turnout that is not safe. In addition, the expense of removing and inserting the better ties elsewhere to obtain the advantage of their remaining service life is saved.

Where a number of weak ties are grouped together, which would necessitate the replacement of the entire set under the plan of making complete renewals, several years' additional service can sometimes be obtained with safety from most of the ties in the group by a judicious renewal of, say, one-fourth to one-half of them, whereas it is more than likely that no one of them would be fit for use in other less important turnouts if they were all taken out together.

It Is a Waste of Labor to Take Out Good Ties

By J. C. WALLACE
Assistant Chief Engineer, New York, Chicago & St. Louis, Cleveland, Ohio

The useful life of individual switch ties in a set usually varies considerably, depending on the type of timber, the treatment and the location in the set. More useful life can usually be obtained from switch ties if they are left in their original locations and are not disturbed by re-

newal, handling and re-installation. It is a waste of labor to take out switch ties and re-install them in some other turnout for the cost of removal, handling and re-installing usually exceeds the value of the remaining life of the tie. For the foregoing reason, only those switch ties should be replaced which have reached the end of their useful life.

Removes Entire Set in Main-Line Track

By J. J. DESMOND
Division Engineer, Illinois Central, Chicago

In connection with switch-tie renewals, it is essential that a definite plan be followed that will insure that when certain ties in the turnout become decayed, they will be removed. It is considered more practicable, however, to remove all of the ties in main-line and important yard turnouts at a time because a turnout will then be in condition to run without disturbing it for several years. This practice provides better track conditions for a longer time and results in better-riding turnouts than where spot renewals are made. The serviceable ties that are recovered can be used to advantage to replace decayed ties in less important turnouts.

May Be Better to Renew Entire Set

By B. BUSKOVICK
Track Inspector, Chicago, Rock Island & Pacific, Wellsburg, Iowa

If part of a set of switch ties requires renewal and the remainder do not have more than four years of service life left, the whole set should be renewed. The reason for this is obvious and may sometimes be the deciding factor even where some of the ties have much more than four years of life remaining. Where traffic is heavy, and particularly where turnout movements predominate, the rails carrying the heavier movement are likely to cut more deeply into the ties. In this event, it will be necessary either to adze under the less frequently used rails or spring the ties under the other rails in order to bring all rails to an even bearing. Under such conditions, I consider that it is better to renew the entire set and turn the sound ties over for use in less important turnouts.

Is a Matter for Local Forces to Decide

By J. MORGAN
Supervisor, Central of Georgia, Leeds, Ala.

I consider that this is a matter that cannot be covered by a blanket decision, but should be left to the judgment of the local forces. Personally, I do not favor the patching of a set of switch ties in a busy turnout where it can reasonably be avoided. If it is done, however, I think it is better to use ties of about the same remaining service life as those that are left undisturbed. If new ties are used, they must be handled again when the rest of the set is renewed. If ties of about the same age are used for patching, however, the whole set will come out at the same time and no extra handling of the newer ties will be necessary.

It is my belief that all of the ties in a busy turnout should be replaced at one time and that any sound ties that are salvaged should be used for patching minor turnouts or for prolonging the life of important sets of ties in accordance with the foregoing, but that the decision should be left to the local forces.

[Replies to this question were also received from W. H. Sparks, general inspector of track, Chesapeake & Ohio; Henry Becker, section foreman, St. Louis-San Francisco; G. E. Broussard, roadmaster, Southern Pacific; H. E. Herington, section foreman, Minneapolis & St. Louis; and W. E. Tillett, assistant foreman, Chesapeake & Ohio. Messrs. Sparks, Herington and Becker favor spot renewals as a general practice, although Mr. Becker suggested that if more than two-thirds of the ties need renewal the entire set should come out. On the other hand, Messrs. Broussard and Tillett were inclined toward complete renewal and the reuse of the sound ties, except in cases where only one or two ties have failed.—Editor.]

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Replacing Floor Beams

Where traffic must not be interrupted, how should one go about replacing a floor beam in an open-deck single-track through truss span? A double-track span without a center truss?

Proper Planning Is Essential

By H. S. LOEFFLER
Bridge Engineer, Great Northern, St. Paul, Minn.

If the floor system is of the type in which the ends of the stringers are riveted to the webs of the floor beams, the usual procedure for replacing a floor beam in a through-truss span, of either single or double-track design, is as follows:

1. Complete all preliminary work, such as loosening deck fastenings, replacing field rivets with bolts, etc.
2. Remove a panel of stringers on one side of the floor beam and support temporarily the ends of the stringers on the other side. This may be done by means of light falsework or by suspending the stringers with steel cables from a beam laid across the top of the trusses.
3. Remove the old floor beam and insert the new one.
4. Replace the stringers and deck.

If these operations are well-planned and if proper erection equipment is used, the work can be done in a short interval between trains. If there is insufficient time between trains to execute the work as outlined, it will become necessary to install falsework to support the stringers and the live load that will come upon them while the floor beam is being changed out.

No definite procedure can be outlined for the latter case since the type of falsework will depend not only on the design details of the floor system, but also on the general conditions peculiar to the truss span concerned. If the span is over a stream, pile falsework may be necessary and the driving may cause more interference with traffic than the replacement of the floor beam by the usual method outlined. If the span is located over railway tracks, the problem may be complicated by the necessity for providing falsework clearance to avoid interference with traffic at the lower level.

If the floor beam is near the center of a long span, it may be necessary to take into consideration the deflection of the span in connection with the design of the falsework. Otherwise, failure may occur in some of the stringer-floor beam connections.

Assuming that it is practicable to place falsework to support the stringers on each side of the floor beam to be replaced, the old floor beam can then be cut apart and the new floor beam assembled in place and riveted. The design of the old floor system will determine the proper method for detailing the new floor beam so that it can be installed without interference. It may be necessary to furnish the web plate in two or more pieces, properly

spliced, and it may be necessary to do all of the riveting in the field, including the driving of the flange rivets in the floor beam after the new floor beam is assembled in the structure.

Usually Sufficient Time to Make Change

By Supervisor of Bridges and Buildings

If all of the work preliminary to the removal of the old floor beam has been completed, the actual replacement can usually be made very quickly, so that there should be no difficulty in finding a time when there is a sufficient interval between trains to avoid interference with traffic. The preliminary work should include the cutting out of all rivets in the floor-beam and stringer connections and the substitution of bolts; preparation for the quick removal of the track over the floor beam and adjacent stringer spans; and provision for supporting the loose ends of the adjacent stringers while the change is being made. The new floor beam should be set out along the track at the end of the bridge ready to be picked up and moved in. All other material and tools should be on hand and checked well in advance of starting the work.

As soon as the track is clear, removal of the connection bolts can be started. At the same time the removal of the track should begin. If the stringers are to be suspended, the slings should be applied and the ropes tightened, or if they are to be supported on falsework the shims should be driven as soon as the track is out of the way.

At this time, the derrick should be brought in and attached to the old floor beam. As soon as the few bolts, which have been allowed to remain till this time, are removed, the old floor beam can be lifted out and the new one brought in and set in place. The operations of full-bolting, restoring the track and clearing the deck require little time. The last operation, which can be carried on under traffic, but under slow-order protection, is to replace the bolts with rivets.

There are special cases which require entirely different procedure, but a discussion of these would be entirely too long to be suitable as an answer to the question, while the average division gang never has to meet the conditions under which the work must be done.

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Handling Creosoted Material

What is the most satisfactory method of handling freshly creosoted stringers, caps, sills, piling and other heavy timbers? What precautions should be observed?

Hand Method Is Slow but Safe

By W. J. HOWSE

Bridge and Building Foreman, New Orleans & North Eastern, Poplarville, Miss.

The proper handling of creosoted piles and timber is a problem that requires considerable time and thought for its solution. The hand method is admittedly slow and laborious, but is by far the most practical way of avoiding injury to the material. When unloading from cars by hand, it is best to use skids to convey the timber to the ground. Heavy timbers should never be permitted to fall from a height greater than six feet, since they may break or split as a result of the fall.

I have found the most satisfactory method, all things considered, of handling heavy timbers, both for loading into and unloading from cars, is to use a derrick. This is a perfectly safe method, provided sharp hooks or tongs are not employed for contacting the timber. There is a device made from ¾-in. steel cable, having a ring at each end, called a sling or loop, which may be used successfully for suspending the timber from the hook on the load line of the derrick. A particular advantage is that the sling does not damage the timber, if properly applied. Several pieces of timber can be handled at each lift where the sling is used, whereas only one piece can be handled at a time with tongs and some damage is likely to result from the use of the latter.

Closely allied to the subject of handling is another matter of great importance, which I think is not out of order in this discussion. I refer to the fire hazard. The inflammability of freshly creosoted timber is a problem that confronts every foreman at points where such timber is assembled. It is our policy to reduce this hazard by applying a fireproof covering.

Finds Timber Grab Hook Superior

By L. G. BYRD

Supervisor Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

Timber is creosoted for one purpose only—to protect it against decay-producing fungi and wood-eating insects. Since the principal protection provided by the treatment is at the surface of the timber, cutting, puncturing or abrading this surface may have an adverse effect on its service life, since untreated or only partially treated wood may thus be exposed. For this reason, every precaution should be taken to avoid such damage. Otherwise, the performance may be but little better than that of untreated material. If the shell containing the treatment remains unbroken, however, the life may be so extended that the structure of which it is a part can be classed as permanent.

My experience has taught me that in handling creosoted timber received fresh from the treating cylinders, and this applies with equal force even if a certain amount of seasoning has taken place, a specially designed grab hook, which is readily available on the market, is most satisfactory. This device can be used with any crane having a boom of sufficient length to handle the timbers. It is so designed that the point on the hook penetrates about 1½ in. into the end of the stick, but does not cut, split or splinter the wood. Practically all woods offer less resistance to the penetration of the preservative parallel to the grain than against the grain. For this reason, the depth of treatment is greater at the ends than on the sides or circumference, so that the timber is not damaged by the hook.

If piling is to be unloaded with hoisting equipment, it should be handled by two sling lines so spaced that the pile will balance when it is raised from the car. If the unloading is done by hand, it may be necessary to turn the pile with a peavy. If this must be done, great care should be exercised to insure that the hook is used far enough from the end to insure that the surface will not be splintered.

Special care should also be exercised to insure that when a pile or timber is rolled from the car it does not strike other timbers, as this usually damages the edges or bruises the surface, often more extensively than is realized. It is best, therefore, when unloading by hand, to use a slackening line, especially if the timbers or piling are more than 30 ft. long. One end of the line can be tied to the side of the car opposite to the one from which the unloading is to take place. It should then be brought under the timber and back to the truss rod for slackening. With this method a car can be released in 30 to 35 min.

Painting Radiators

What are the advantages and disadvantages of ordinary paint and bronze paint for radiators? How is the heating value of the radiators affected?

Non-Metallic Paints Increase Heat Exchange

By C. MILES BURPEE
Research Engineer, Delaware & Hudson, Albany, N. Y.

The extensive use of aluminum and gold-bronze coatings for radiators has doubtless been due to the serviceability of these materials for this purpose. In many instances, however, finishes of this character do not blend well with the general color scheme of interior decoration, as the radiators and piping are over-emphasized and brought into a prominence that does not harmonize with the furnishings or general surroundings. For office use, a flat finish, such as is used on the interior walls, or an enamel, produces a more attractive finish from the decorative view point. If properly applied, such a finish rarely cracks or peels, while it may be washed and is durable.

Repeated tests have indicated that aluminum or gold bronze retards the emission of heat up to as much as 20 per cent. Where heating efficiency is required, the most satisfactory finish is a white or light-tinted wall paint, which protects the metal without impeding heat transmission. The following table, taken from the Transactions of the American Society of Heating and Ventilating Engineers, shows the variations in heat-radiation tests conducted on a two-column, 38-in. radiator with a steam temperature of 215 deg. F., and a room temperature of 70 deg. F.

Finish	B. t. u. transmitted per square foot of radiator per hour	Relative heating value per cent
Bare cast iron	240	100
White enamel	242	101
White zinc	242	101
Maroon japan	240	100
No-Luster green enamel	230	96
Gold bronze	205	85
Aluminum bronze	200	83

John R. Allen, in a paper entitled, Heat Losses from Direct Radiation, declares that any paint composed of flake metal has poor radiating characteristics and that radiation depends on the final coat regardless of the primer. For this reason, if a radiator already has a coat of either aluminum or gold bronze and is then coated with a lighter-colored non-metallic flat paint, i.e., one which does not contain flakes of pure metal, a considerable increase in heat radiation may be expected, for the primer forms good adhesion, sealing pores and acting as a good conductor of heat, while the flat top or finish coat forms a good radiating surface. An interesting discussion of this subject may also be found in Bulletin 107 of the Bureau of Standards.

Metallic Finishes Reduce Efficiency

By FRANK R. JUDD
Engineer of Buildings, Illinois Central, Chicago

In general, the practice of painting radiators is based on the same principles of decorative effect as the treatment of walls and trim. Several years ago it was customary to use metallic paints, usually aluminum or bronze, on radiators. They were readily applied and easy to maintain, while they lasted better than paints having an oil vehicle. More recently, it has become the practice to use colors that harmonize with the color scheme of the room, with the result that the use of bronze and aluminum paints has been somewhat reduced.

There is a distinct advantage in using paint on radiators for decorative purposes. The color of the paint has little effect on the efficiency of radiation. Metallic paints, such as aluminum and bronze will, however, reduce the heat-radiating value of the radiator, the reason being that bright metals have a low radiation coefficient. Paints for use on radiators should have a varnish vehicle instead of an oil vehicle. The number of coats applied does not affect the efficiency of the radiator, but the character of the final coat does determine the efficiency. It is possible to apply a priming coat of aluminum or bronze and cover it with a paint that does not give a bright metallic finish and still obtain high efficiency. Yet if the final coat is aluminum or bronze, the efficiency of the radiator will be reduced, irrespective of the character of the preceding coat.

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Applying Anti-Creepers

Where tie renewals are heavy and new rail is to be surfaced immediately, should anti-creepers be applied by the rail gang or by the surfacing gang? Why?

Should Be Applied at Once

By ARMSTRONG CHINN
Chief Engineer, Alton, Chicago

Anti-creepers should be applied to new rail by the rail gang as soon as possible after it is laid, regardless of any other work that may be planned. The best results are obtained when they are applied before traffic is allowed on the new rail and, at the latest, they should go on before the expansion shims are withdrawn. A good time to apply them is immediately behind the men who are tightening bolts.

Anti-creepers have only one purpose—to hold the rail in place so that it cannot creep and destroy the even distribution of the expansion allowance that is provided when the rail is laid. The tendency of rail to creep will begin with the first train over it, for which reason anti-creepers should be in place to protect it against this initial tendency. The evils that result from improper or uneven expansion are too well known to require discussion, but they do point to the necessity for taking every precaution to prevent the rail from moving after it is laid.

Modern anti-creepers are so designed that they can be removed and reapplied several times without detriment to their holding power. If new rail is to be surfaced immediately behind the rail gang, the surfacing gang can re-apply those anchors that do not conform to the new tie spacing.

Too Much Time Elapses—Laying to Surfacing

By J. C. PATTERSON
Chief Engineer Maintenance of Way, Erie, Cleveland, Ohio

All anti-creepers, with the possible exception of those at the joint ties, where these ties are to be respaced, should be applied by the rail gang as the rail is laid. Where it is necessary to respace these ties, the anchors should be removed by the surfacing gang as the ties are renewed and spaced. The reason for this is that one of the important requirements for maintaining proper track conditions is to lay new rail with correct expansion, and then maintain this expansion after the rail has been placed in service.

Despite the fact that the new rail is to be surfaced

immediately, an interval must elapse, the length of which will depend on the size of the job and of the gang engaged in the work, before the surfacing can be completed. In the meantime, a number of trains will probably pass over the new rail. If it is not anchored, it is quite likely that the expansion will be altered by creeping.

It may be contended that if the rail is anchored when laid, the expansion may still be lost when the track is skeletonized. The answer to this is that where these conditions occur, the allowable speed is so slow that creeping does not take place.

Where traffic is normally in one direction, the surfacing gang should begin at the end of the job facing the traffic and progress with the traffic, to insure that the braking of trains for the purpose of reducing speed will be done prior to entering the slow-order territory, and that the application will not occur on the new rail before it is worked over.

Uniform Expansion Is Most Important

By J. C. WALLACE
Assistant Chief Engineer, New York, Chicago & St. Louis, Cleveland, Ohio

Anti-creepers have as their principal purpose the prevention of creeping rail. Assuming that a sufficient number are provided to prevent creeping, with all the attendant evils of sluing ties, tightening of gage and shifting of the ties off of their tamped bed, the only remaining purpose of anti-creepers, and I consider this to be equal in importance to the prevention of creeping, is the maintenance of uniform expansion between the rail ends.

It is obvious, therefore, that the anti-creepers should be applied by the rail gang as soon as the rail is laid, and that they should be removed and re-applied by the surfacing gang immediately after the necessary ties have been renewed and respaced and the track surfaced.

Surfacing Gang Should Install

By G. O. BROUSSARD
Roadmaster, Southern Pacific, Morgan City, La.

With the many years of experience in rail renewal and surfacing which the railways and particularly their maintenance officers have as their background, there should be no question about the method of laying and surfacing rail. The surfacing gang should be so organized that its work will follow that of the rail gang at an interval of not more than five or six days. If this can be arranged, then, by all means, the anti-creepers should be applied by the surfacing gang. This will avoid the unnecessary abuse which may occur when they are put on and then taken off for the purpose of surfacing, after which they must be re-applied. Obviously, if it is not practicable to do the surfacing and renew the ties within five or six days, the anti-creepers should be installed by the rail gang to avoid the probability that the expansion will bunch and thus allow the rail to expand and contract without uniformity.

Take No Chances on the Rail Creeping

By H. S. CLARKE
Engineer Maintenance of Way, Delaware & Hudson, Albany, N. Y.

One should take no chances, in view of the insignificant expense of applying and, perhaps, of re-applying anti-creepers, but should protect the track when the rail is laid. Doing so may save considerable expense later when the surfacing is done, for bucking back the rail and repairing other damage that is so characteristic of creeping track. The fact that ties are so poor that heavy renewals are necessary is an indication that the support of the rail is not substantial. The less substantial the substructure, the greater the wave motion under load, and thus the greater is the need for protection.

A great amount of damage can be done in a very short time under certain conditions. If the rail is a light section, if the substructure is poor or if the track is on a heavy descending grade with an alinement that includes sharp curvature, even one heavy-tonnage train may close up all spaces allowed for expansion and push turnouts or fastenings out of position. Kinks may also be caused.

Local conditions govern in every case, but if anti-creeper protection is needed at all, it should be given immediately at the time the rail is laid.

[Additional answers to this question were received from W. H. Sparks, general inspector of track, Chesapeake & Ohio; Robert White, section foreman, Grand Trunk Western; and W. E. Tillett, assistant foreman, Chesapeake & Ohio, all of whom favored having the application made by the rail gang.—Editor.]

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Rail Tonnage

What simple rule can be employed to determine the number of rails in a given number of tons? To determine the tonnage of a given number of rails? To determine the number of tons in a mile?

Rule for 33-Ft. Rails Is Simple

By J. H. GUEST
Roadmaster, Missouri-Kansas-Texas, Woodward, Okla.

The approximate weight of a 33-ft. rail, in tons of 2240 lb., is $\frac{W}{200} - 0.01$, in which W represents the weight per yard.

For example, a 33-ft., 110-lb. rail weighs $\frac{110}{200} - 0.01 = 0.54$ tons.

To obtain the number of rails in a given number of tons, divide the weight of one rail thus obtained into the number of tons. To determine the tonnage of a given number of rails, multiply the number of rails by the tonnage in one rail.

To determine the number of tons in one mile, $T = \frac{11 \times W}{7}$

(This figure will be exact).

Depends on Weight and Length of Rails

By AMSTRONG CHINN
Chief Engineer, Alton, Chicago

The number of rails in a given tonnage will depend on the weight of the rail and the length of the individual rails. It must also be assumed that all of the rails are of the same weight and length, since otherwise there can be no possible solution. As there are many weights of rail and numerous standards of length, any useful rule must provide for these two variables. If we know the number of tons in one rail, it is easy to determine the number of rails in a given number of tons, by dividing the latter number by the former. The first essential is, therefore, to develop an easy method for finding the number of tons in any rail of any length. It will be found that the number of tons in one foot of rail weighing one pound per yard is 0.000148809. Hence, the num-

ber of tons in any rail is 0.00014809 multiplied by the weight (W) of the rail in pounds per yard, times the length (L) of the rail in feet. If T represents the number of tons and N the number of rails, then

$$N = \frac{T}{0.000148809 \times W \times L.}$$

As an example, how many 33-ft. 90-lb. rails are there in 141.428 tons?

$$N = \frac{141.428}{0.000148809 \times 90 \times 33} = 320$$

To determine the tonnage in a given number of rails, multiply the number of rails by the number of tons in one rail. For example, to find the number of tons in 320 rails 33 ft. long, weighing 100 lb. to the yard; the formula is

$$T = 0.000148809 \times W \times L \times 320$$
$$T = 0.000148 \times 100 \times 33 \times 320 = 157.142$$

To determine the number of tons of rail in one mile of track, only one thing need be known, that is, the weight of the rail. First determine the number of tons in one mile of track (two rails) laid with rail weighing one pound per yard. This is 1.5714286. Then the tonnage in one mile is 1.5714286 W. If 100-lb. rail is to be used, the tonnage is 1.5714286 × 100=157.142. If 112-lb. rail is used 1.5714286 W=176.

These calculations are based on new unworn rail. If the rail is worn, it will be necessary to make an allowance, depending on the amount of wear, to arrive at the correct weight of the rail.

Chart Simplifies Calculations

By J. R. SCATTERDAY

Roadway Engineer, Chesapeake & Ohio and Allied Lines, Cleveland, Ohio

This is a somewhat complicated question to be answered by a simple rule which will cover different weights and lengths of rails. Whether a factor or table is prepared, it is always necessary to perform some multiplication or division to arrive at some of the required figures. To avoid these computations I have prepared the accompanying chart which is quite simple, and which can be placed on the desk or carried in a note book or in one's pocket for handy reference when in the field.

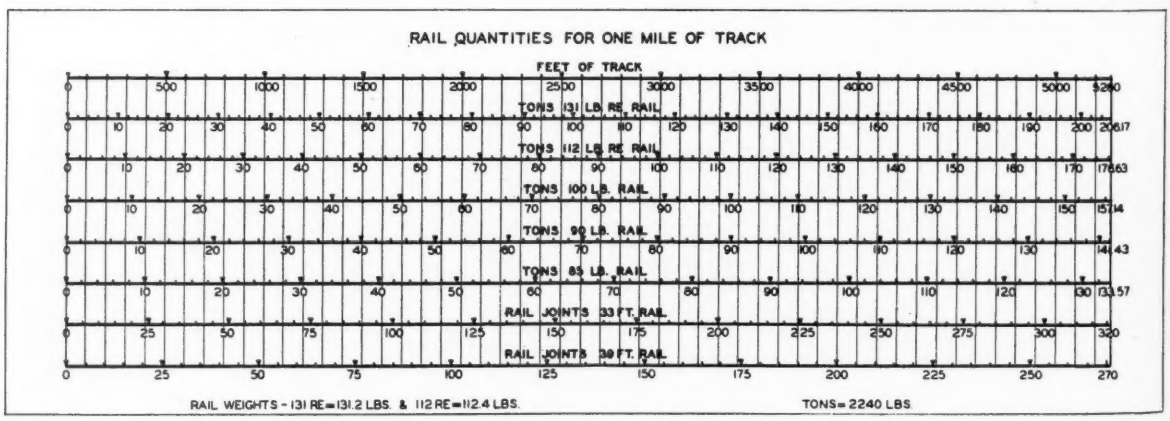
RAIL QUANTITIES FOR ONE MILE OF TRACK
FEET OF TRACK
TONS 131 LB. RE. RAIL
TONS 112 LB. RE. RAIL
TONS 100 LB. RAIL
TONS 90 LB. RAIL
TONS 85 LB. RAIL
RAIL JOINTS 33 FT. RAIL
RAIL JOINTS 39 FT. RAIL
RAIL WEIGHTS - 131 RE=131.2 LBS. & 112 RE=112.4 LBS.
TONS=2240 LBS

Chart for Determining Rail and Joint Quantities

To show the ease with which it can be used, suppose one has 35 tons of 131-lb. 33 ft. rails on hand and wishes to lay 4,600 ft. of track. By reference to the chart it is found that there will be required 276 joints. Thirty-five tons will lay 900 ft. of track and 144.5 additional tons will be required to lay the remaining 3,700 ft. of track.

Effect of Prolonged Dry Weather

How is the quality of water for locomotive use affected by a prolonged dry spell, where the supply is taken from streams? What remedial measures should be taken? What is the effect on small streams when the dry spell is followed by light rains?

Character of Stream Makes Difference

By Supervisor of Water Stations

Prolonged dry weather may have a decided effect on the quality of the water in small streams, but this will depend on the characteristics of the stream and of the watershed. In some cases the quality may be improved, as where the watershed is uncultivated but subject to erosion, in which case there will be a marked reduction in the amount of suspended matter carried in the water. This is particularly true of streams in the South. In the larger streams the quality of the water will be more uniform. If the stream receives its supply from drainage ditches or tile drains, the water will probably increase in hardness during dry weather. There will also be a tendency toward an accumulation of algae. A stream fed by springs or one with a wooded watershed is not materially affected by either drought or rainfall.

Pollution from industrial wastes is always at its worst during low stages. As an example, during the 1930 drought some streams taking mine drainage became so high in sulphuric acid that the water stations taking water from them had to be abandoned, in one case the sulphuric acid concentration being as high as 150 grains to the gallon. During the same period the hardness of the water in the Ohio river increased from 6 grains per gallon to 14.

Light rains after a prolonged dry spell have little effect on small streams because little of the rainfall reaches the stream. If the precipitation is sufficient to increase the flow, however, the character of the water is affected materially. The hardness, the organic content and the amount of suspended matter usually all increase considerably.

It is difficult to suggest a remedy for or measures calculated to guard against the effect of prolonged droughts. One method is to provide for the storage of sufficient water to carry over the dry spell and thus protect against the probability of polution, although this is rarely practicable. Where the hardness is increased, another alternative is to provide temporary treating facilities or a change in the treatment that is normally given. Where

gross pollution occurs from organic matter or mine wastes, there is little that can be done to correct the conditions, and it may be necessary to seek another source of supply as a solution to the problem.

Depends on Source of Stream

By E. M. GRIME

Engineer of Water Service, Northern Pacific, St. Paul, Minn.

What the effect of a dry spell will be on the quality of the water in a stream depends in large measure on the source of the stream and the kind of country it drains. If it is a mountain stream fed by glaciers, melting snow or permanent springs, there will be practically no change. If it drains a rolling prairie section, with the gradual drying up of water pockets and other sources of flow, the pure water is drawn off by evaporation and what remains becomes more concentrated in both incrusting and non-incrusting solids. This may be particularly noticeable where the stream flows out of small lakes or reservoirs.

Where the water is being softened by some treating process, the obvious remedy is to change the chemical dosage so as to hold the incrusting salts to as low a point as practicable, without unduly increasing the non-incrusting alkali salts.

In small streams, light rains usually dilute the flow sufficiently to have a marked softening effect, but sometimes the reverse is true and the water becomes harder than before. This may be the case where there is an alkali soil or where irrigated land is drained, and the rain washes into the stream the salts that have leached out of the ground during dry weather.

One of the most common effects of rain is largely to increase the turbidity of most streams, and in some cases, before the water can be used in locomotives it may be desirable to use some heavy-floc-creating agent, such as alum, iron sulphate or sodium aluminate, which will cause rapid settlement of the suspended particles of silt or other foreign matter.

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Churning Ballast

Where stone ballast is churning and a general cleaning is not practicable, what action should the section forces take? Why? How should they go about it?

Only Clean Ballast Is Free from Churning

By W. H. SPARKS

General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

This is a subject that should be given far more thought than it sometimes receives. There are few conditions, except unstable roadbed, that make track maintenance more difficult. In discussing the subject, however, it should be borne in mind that only dirty ballast churns, and that only clean ballast is free from the trouble.

It is of first importance that the gang go over the entire section, cleaning the ballast at all joints and well back of the shoulder ties. If time and the size of the force permit, this cleaning should include the cribs, although in most cases this is impracticable. At this time the joints should be surfaced and the bolts tightened. This should be done every year until the general condition has been corrected.

In cleaning the ballast, the shoulder should be broken down at the ends of the ties to the roadbed, or well below the ties, cleaned and forked back. Then as time permits, the remainder of the shoulder should be treated in the same manner. In some types of gravel ballast forks cannot be used, but even the digging out of the ballast will loosen it up and improve conditions materially.

Hand Cleaning Is Only Remedy

By G. O. BROUSSARD

Roadmaster, Southern Pacific, Morgan City, La.

I have had considerable experience with the conditions suggested by the question and have found that where stone ballast is churning and a general cleaning is not practicable, the section gangs should be equipped with ballast forks. As the track is spotted in smoothing it, the ballast should be removed to a reasonable distance below the bottom of the ties and cleaned with forks out on the sub-grade, the cleaned ballast being returned to place. This will improve the drainage and eliminate the churning. My experience has also included other forms of ballast, and this process has given very satisfactory results with these other materials.

The Ballast Must Be Cleaned

By W. E. TILLETT

Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

Churning occurs only in dirty ballast, which makes the remedy obvious. When a general cleaning is not practicable, the next best thing is to clean the worst places, usually around the joints, by hand. To do this with stone ballast, the shoulder should be broken down to at least 2 in. below the ties and cleaned with forks. After a reasonable stretch of track has been cleaned in this manner, it should be given a light raise.

In bank-run or washed gravel, the dirt may form a crust as much as two or three inches thick, and the drainage can sometimes be considerably improved by breaking up and cleaning this crust. Where drainage conditions are exceptionally bad, a general cleaning, a light surface and enough new ballast to complete the section, afford the only permanent solution of the difficulty.

Temporary Relief by Bleeding

By THOMAS WALKER

Roadmaster, Louisville & Nashville, Evansville, Ind.

Where ballast is churning badly, the quickest way to get temporary relief in wet weather is to bleed the ballast at the ends of the ties in order to let the water drain out. This can be done quickly with a pick, but the relief thus obtained is only temporary and partial. A better job can be obtained by cutting down the ballast at the ends of the ties to the bottom of or about 2 in. below the ties in order to get more complete drainage. Churning track is caused primarily by wet conditions and pumping ties, so that it is obvious that anything which will tend to correct these conditions will afford some relief.

More lasting relief can be obtained by giving the track a light surface, tamping the ties solidly, since the tamping and surfacing will, to an appreciable extent reduce the pumping motion of the ties. When track is churning it is probably advisable not to keep the spikes driven down tight against the rail. A little clearance between the head of the spike and the base of the rail may also tend to reduce the pumping movement slightly.

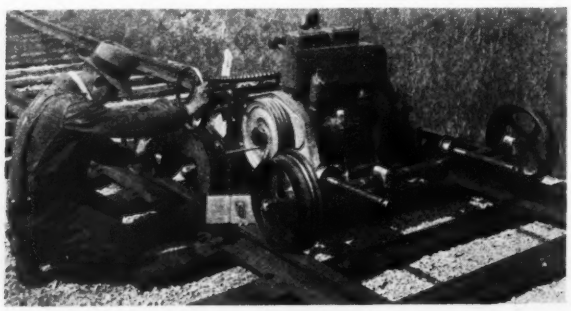
Churning stone ballast is very troublesome and all of the foregoing suggestions will afford only temporary relief. A thorough surfacing of the track will help for some time, but the churning will usually begin again unless a major cleaning operation is performed.

NEW AND IMPROVED DEVICES

Nordberg Develops New Rail Grinder

THE Nordberg Manufacturing Company, Milwaukee, Wis., has developed a new four-wheel rail grinder that embodies a number of radical changes in design, as compared with previous models manufactured by this company. One of the principal features of the new grinder is the four-cylinder, air-cooled motor with which it is powered, this motor being adapted particularly for this application. The motor is said to give a smooth flow of power which, combined with the improved mounting and more sturdy construction, results in the elimination of vibration.

The new grinder is known as the BG type Nordberg grinder. It consists principally of two assemblies, the



The New BG Type Nordberg Rail Grinder

truck and the grinder carriage. The latter consists of an underframe equipped with four large grooved rollers which operate in pairs on steel tubes that serve also as housings for the axles of the truck. Mounted on this carriage are the motor, the V-belt drive, the grinding spindle and the actuating mechanism for the grinding wheel. This entire assembly moves back and forth on the rollers as the grinding wheel is moved across the rail. The grinding wheel is raised and lowered by means of a large, conveniently located handwheel which operates through a pinion and geared segment.

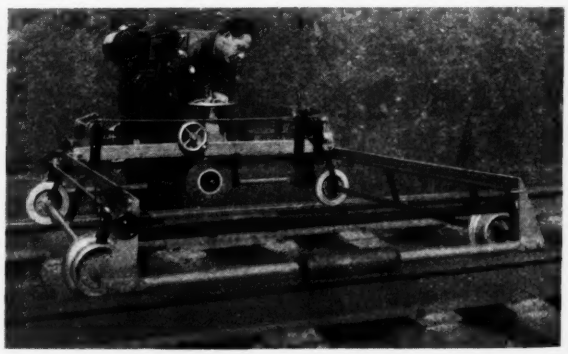
The engine develops from 12 to 16 hp. and is said to have sufficient power to make heavy cuts without lowering the engine speed. As the grinding wheel wears down, the correct surface speed is maintained by means of the engine governor which is adjusted manually to obtain the desired speed.

This grinder is equipped with a flexible shaft for slotting joints, grinding switches and frogs, and for similar work. The shaft drive has an overload release to protect the shaft from damage if the wheel should become snagged. The shaft is of such design that when it is in its normal operating position it forms practically a straight line, thereby reducing the wear on it to a minimum. The shaft is said to be of stronger construction than that used on previous models and to have end and hand pieces of greatly improved design.

New Track Grinders

THE Railway Trackwork Company, Philadelphia, Pa., has added a number of new models to its line of track grinders, these new models including units for all of the various classes of grinding necessary in the track, and embodying refinements in the form of materials, ease of operation and desirable adjustments. The new models include the P-21 and P-15 grinders, which are gasoline engine-driven units designed for grinding off welds made in repairing rail ends or special track work; the P-16 grinder, also an engine-driven unit, designed essentially for removing overflowed metal from switch points and stock rails; and the P-22 grinder, an off-track unit, which is designed for the free-hand grinding of welded rail ends, crossings and frogs, and also for grinding flangeways, switch points and stock rails.

The P-21 grinder, which is driven by a four-horsepower gasoline engine with a V-belt drive, is moved



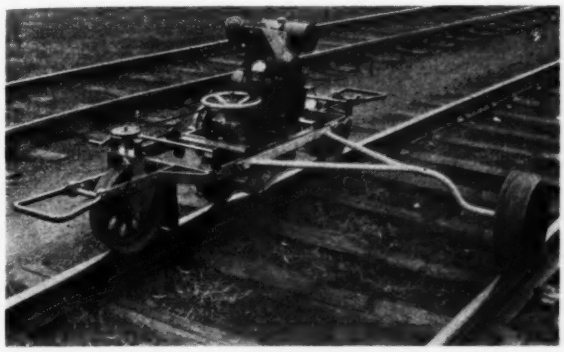
The Model P-21 Grinder

along the track on a four-wheel frame, and provides for both transverse and longitudinal movement of the grinding wheel with respect to the rail, while the frame mounting itself remains fixed. It also provides for shifting the grinding wheel laterally from one rail to the other, without turning the frame. All of the different movements are on ball bearings with adjustment to compensate for wear.

Adjustment of the grinding wheel feed is effected by means of a large handwheel, while lateral movement is by means of a small handwheel. A crank handle pro-

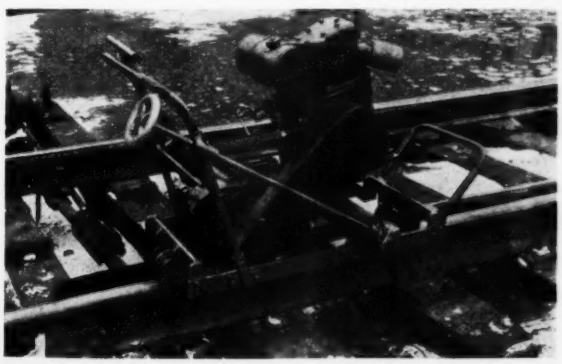
duces the longitudinally reciprocating motion along the rail. A feature of the Model P-21 grinder is an arrangement whereby one end is provided with a vertical adjustment by means of which the wheel can be raised to obtain a gradual run-off at the ends of welds.

The grinding wheel used with the P-21 is 10 in. in diameter and has a 1¼-in. face. It is designed for high-speed grinding, but its speed is regulated by a governor to 9500 surface feet a minute. A flexible shaft, operating a six-inch diameter wheel for opening and beveling rail ends after welding, can be furnished with the machine, this having ready attachment to the spindle of the regular grinding wheel. The Model P-21 weighs 700 lb., and is 80 in. long and 87 in. wide. It is readily removed from the track by means of a ball bearing-mounted roller provided on each side of the frame.



The Model P-15 Grinder

The Model P-15 grinder is similar in many respects to the Model P-21, in that it is powered with a four-horsepower gasoline engine, uses the same size grinding wheel, and provides for the transverse and longitudinal movement of the wheel with respect to the rail on ball bearing mountings. The principal difference between the P-15 and the P-21 models is that the P-15 unit is carried on a two-wheel running frame, with a detachable third wheel for support on the opposite rail.



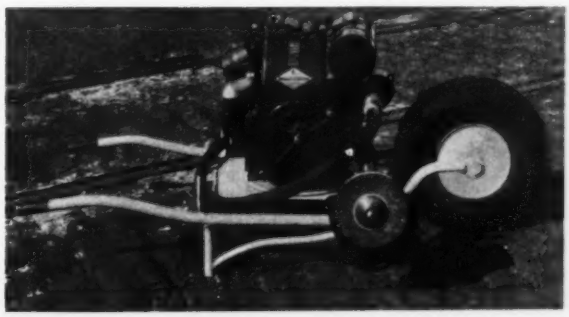
The Model P-16 Grinder

All of the movements of this unit are controlled in a manner similar to those of the P-21 grinder, the principal exception being that the entire unit must be turned around if grinding is shifted from one rail to the other. The unit as a whole weighs 545 lb. and is designed to be lifted from the track to clear for trains. The overall length of the grinder, from out to out of lifting handles at the ends, is 107 in.

The Model P-16 grinder, which is designed for grinding the side faces of switch points and stock rails, consists essentially of a double-cup grinding wheel, 10-in. in diameter, driven by a four-horsepower air-cooled gasoline engine, mounted on a steel carriage which is supported on the track rails by two double-flanged wheels and a third roller-type guide wheel. This unit, which is moved along the track by means of a push handle at one end, provides for lowering the grinding wheel to the depth desired and for moving it laterally to follow the alinement of the switch point or the stock rail being ground. A handle on the grinder head produces the former movement, while a handwheel alongside the push handle controls the lateral adjustment and feed of the grinding wheel. By means of the lateral adjustment, the entire grinding operation on both the switch point and the stock rail can be effected without turning the machine. Furthermore, by means of an adjusting device on the third-wheel support side of the grinder frame, the entire machine can be tilted out of a vertical plane to obtain the angle of grinding desired.

The machine can be powered with an electric motor instead of a gas engine, if desired, and can be equipped with a flexible shaft for operating an eight-inch handwheel. The total weight of the machine is 355 lb.

The Model P-22 grinder is a portable, flexible-shaft unit, mounted on a one-wheel, barrow-type carriage for movement alongside the track. This unit, which is also driven by a four-horsepower gasoline engine, is intended for free-hand grinding. For the various classes of track grinding it is adapted for using various attachments and either straight or cup-type grinding wheels. A feature of the unit is the arrangement whereby the bed plate supporting the entire power unit is on a swivel mounting. This permits free movement of the engine and thereby greatly facilitates the handling of the flexible shaft. This machine can also be furnished with an electric motor drive, if desired.



The Model P-22, Off-Track, Flexible-Shaft Grinder

A Characteristic View on the Grand Trunk Western

News of the Month . . .

Estimate 4.5 Per Cent Increase in Third Quarter Loadings

Freight car loadings of the 29 principal commodities in the third quarter of 1934 will total 5,172,897 cars, as compared with actual loadings of 4,950,860 cars in the corresponding period of 1933, an increase of about 4.5 per cent, according to estimates compiled by the 13 shippers' regional advisory boards. Eleven of the 13 boards anticipate that loadings in their regions for the third quarter will show increases over last year, one anticipates a decrease and one estimates that the loadings will be practically the same. Of the 29 commodities covered in the forecast it is anticipated that the carloadings of 20 will increase over last year, while those of the other 9 will show decreases.

Waite Resigns as P. W. A. Deputy Administrator

Col. Henry M. Waite, who resigned as chief engineer of the Cincinnati Union Terminal in 1933, to become deputy administrator of the Public Works Administration, has resigned from that position, effective September 1. The resignation was announced with regret by Public Works Administrator Harold L. Ickes, who praised Colonel Waite for his "splendid contribution to the recovery program". Colonel Waite is leaving the P.W.A. to return to Cincinnati where he will take charge of the Department of Economic Security, an organization designed to cope with unemployment and rehabilitation problems, which is being sponsored by the city of Cincinnati, Hamilton County, Ohio, and the Spelman Foundation. An engineer of broad experience, Colonel Waite is particularly noted for his work in connection with the construction of the Cincinnati Union Terminal, of which he was chief engineer during the construction period.

Warns Against Further Regulation of Business

A warning against further governmental regulation which would stifle the individual initiative upon which the industrial leadership of the United States was erected, was delivered by George H. Houston, president of the Baldwin Locomotive Works, during an address on July 14. "While all recognize", he said, "that the insecurities of the recent depression years have been destructive of much of the material prosperity upon which we have prided ourselves, yet in seeking for the cure for this insecurity, great care is necessary not to so regulate and control the private affairs of our people as to discourage new enterprise and foreclose opportunity to the individual.

"I do not believe the answer lies in further governmental penetration into private enterprise, but rather, in the withdrawal of government from undue regulation of and interference with business, and in the freeing and stimulating of the impulses of the individual to participate again in private enterprise in search of a profit through the free and untrammeled production of the goods and services needed by the country."

Railroad Purchases in May Rise 95 Per Cent Over May, 1933

Total purchases of materials and supplies, exclusive of new cars and locomotives, made by the railroads in May amounted to approximately $60,500,000, which is the largest expenditure of any one month in three years and about 95 per cent more than was spent in May, 1933, excluding fuel. Purchases in May amounted to about $41,100,000, including about $4,700,00 for crossties, $4,800,000 for rails, and $31,600,000 for other materials. While higher prices, due to N.R.A. codes, were responsible for a portion of the increase in purchases in May, the larger part of the increase was attributed to the fact that the railroads actually bought materials and supplies in larger volume. Excluding new cars and locomotives, purchases for the first five months totaled approximately $258,000,000, including $93,178,000 for fuel, $19,431,000 for crossties and $145,391,000 for rails and other manufactured materials, as compared with $155,600,000 in the same period of 1933, including $67,950,000 for fuel, $10,380,000 for ties and $77,270,000 for other materials.

I. C. C. Permits Truck-Competitive Rates on Livestock

For the purpose of enabling the railroads to meet the competition of highway motor trucks in the transportation of livestock, the Interstate Commerce Commission has authorized the railroads to establish and maintain rates on livestock, in carloads, between points in western trunk-line territory for distances of 800 miles or less, without observing the long-and-short haul provisions of Section 4 of the Interstate Commerce Act. Thus, on the basis of this ruling, the railroads will be enabled to reduce their charges per car on small-lot shipments of livestock. In connection with its decision, the commission cited figures to illustrate the increase in the transportation of livestock by motor truck that has taken place in recent years. In 1926 and 1932, 59,499 and 145,343 truck loads, respectively, were received at Kansas City, Mo., while in June, 1932, and June, 1933, 14,912 and 18,994 truck loads, respectively, were received at the same market. Livestock shipments received by truck at Kansas City comprised 13 per cent of the total receipts in 1929, 17 per cent in 1930, 21 per cent in 1921 and 30 per cent in 1932. Other livestock centers report similar increases in the proportion of livestock shipments received by truck.

Future Holds Opportunities in Railroading, Says Loree

For the immediate future, openings in the railroad field will be limited but ultimately, when certain changes are effected, there will be a wealth of opportunity therein, according to L. F. Loree, president of the Delaware & Hudson. Mr. Loree made this statement during an address at a "Choosing-a-Career" conference at Newark, N. J., on June 26. He went on to say that he is not troubled about the future of the railroad business as a whole, since the railroads furnish "the best and cheapest land transportation service available; and with the elimination of unprofitable mileage, stations and other facilities which are no longer productive, they will in time, if left alone, work out their problems and fully recover." Mr. Loree's audience was composed of college men and women.

International Express Service Praised by Eastman

The first international express system will be established on August 1 by the Railway Express Agency, Inc., and the Pan American Airways System, thereby providing high-speed shipping service for American foreign trade. Following the announcement of this service, Federal Coordinator of Transportation Joseph B. Eastman issued a statement saying that those who have created this new service are entitled to congratulations and the thanks of the country. "They have," he said, "for the first time placed the great domestic express shipping facilities of the railroads at the command of American industry engaged in foreign commerce, and they have done an equally important thing, namely, co-ordinated rail and air service. It is a pleasure to see the two forms of transportation join hands in this way. The results should be an effective stimulus to good relations and profitable intercourse with our Latin American neighbors."

Low Passenger Fares in Western District Extended a Year

The reduced basis of railroad passenger fares that has been in effect in the Western district since December 1, 1933, was extended for a further experimental period of one year from September 30, 1934, the present expiration date, at a meeting of the Western Association of Railway Executives at Chicago on July 9. The decision to continue the rates for 12 months is based on the results secured since they have been in effect. During the first six months of 1934 the number of passengers carried by railroads in the Western dis-

trict increased 32.72 per cent as compared with the same period in 1933; passengers carried per mile increased 27.5 per cent, and passenger revenues increased 4.71 per cent, although the number of passenger-train miles decreased 0.78 per cent.

The reduced fares include a rate of 2 cents per mile for one-way tickets good in coaches, a rate of 1.8 cents per mile in each direction for short limit, round-trip tickets good in day coaches, the complete elimination of the Pullman surcharge, a rate of 3 cents a mile for one-way tickets good in all classes of equipment, a rate of 2.5 cents per mile in each direction for long limit round-trip tickets good in all classes of equipment and a rate of 2 cents per mile for short limit round-trip tickets good in all classes of equipment.

Five Months Net of Class I Roads Shows Large Increase

Class I railroads for the first five months of 1934 had a net railway operating income of $183,977,640, which was at the annual rate of return of 2.11 per cent on their property investment, as compared with a net of $94,918,398, or 1.08 per cent, in the corresponding period of 1933, according to reports compiled by the Bureau of Railway Economics. Operating revenues for the first five months totaled $1,347,033,883, as compared with $1,136,911,878 for the same period in 1933, an increase of 18.5 per cent. Operating expenses amounted to $1,003,889,536, as against $883,616,031 for the same period in 1933, an increase of 13.6 per cent.

For May these railroads had a net of $39,494,980, or 1.99 per cent, as compared with a net of $41,042,628, or 2.05 per cent, in May, 1933. Operating revenues were $282,023,664 as compared with $255,241,381, an increase of 10.5 per cent. Operating expenses in May were $210,011,001, as against $181,578,430, an increase of 15.7 per cent.

J. J. Cornwell Discusses Government Ownership of Railroads

Vigorous opposition to government ownership of railroads was voiced by John J. Cornwell, general counsel of the Baltimore & Ohio, in a recent address at Cumberland, Md. Mr. Cornwell predicted that government ownership of railroads would be followed by the complete "socialization" of all industry so that finally "we would have a communistic system much the same as there is in Russia". Because of the possibility of government ownership, he urged everybody concerned to accept Co-ordinator Eastman's suggestion to think about and discuss the advantages and disadvantages of public control and operation.

Justification for the present discussion and consideration of government ownership in this country, Mr. Cornwell said, is due to the fact that the railroads have for the past four years been in a difficult financial situation. He thought, however, that if general business continues to improve the railroads will in another year be on solid financial ground, unless the government inaugurates some further detrimental policies.

Association News

Roadmasters' Association

The program is rapidly approaching completion for the forty-ninth annual convention, which will be held at the Hotel Stevens, Chicago, on September 18-20. The reports of the committees are being rounded into final shape, two of the reports being practically completed. The Track Supply Association is proceeding with plans for its exhibit with applications for space coming in rapidly.

Bridge and Building Association

The program for the convention, which will be held in Chicago on October 16-18, is now being formulated. It will include the reports of nine committees which are already finished or are approaching completion. Several prominent railway officers are also being invited to participate in the program. The committee appointed to consider the selection of a hotel is actively at work and is expected to formulate its recommendation shortly.

American Railway Engineering Association

Within a week, members of the association will receive copies of Bulletin 366 containing the annual tie renewal statistics for 1933, a monograph on the New Impact Formulas of Committee XV, by B. R. Loeffler, bridge engineer, New York Central Lines West of Buffalo, and the address on Research As Applied to Railroading, which was delivered by Dr. A. A. Potter, dean of engineering, Purdue university, at the convention in March. Bulletin 367, containing revisions to the Manual as a consequence of action taken at the last convention of the association, will be mailed to the members a week or 10 days later.

Five committees of the association held meetings during the month of July, of which three were in Chicago. These included the Committee on Maintenance of Way Work Equipment, which was attended by 18 members on July 10; the Committee on Buildings, which met on July 17-18 with an attendance of 10; and the Committee on Records and Accounts, which met on July 24 with an attendance of 15. The Committee on Masonry held a meeting in New York on July 19-20, while the Committee on Iron and Steel Structures held a two-day meeting at Detroit, Mich., on July 12-13.

Coal Mixing and Withdrawal Chute.—The Ross & White Company, Chicago, has issued an eight-page illustrated folder dealing with this company's coal mixing and withdrawal chute for railroads. The folder tells how this chute operates to prevent the segregation or separation of fine and large sizes of coal on engine tenders and in coal pockets and shows the results of tests that have been made to determine the effectiveness of the chute in fulfilling this function.

Personal Mention

Engineering

M. H. Doughty, engineer maintenance of way of the Delaware, Lackawanna & Western, has been appointed assistant to the chief engineer, with headquarters as before at Hoboken, N. J. **Albert A. Johnson,** track engineer, has been appointed engineer maintenance of way to succeed Mr. Doughty, and the position of track engineer has been abolished.

O. R. West, division engineer of the Bay Terminals division of the Atchison, Topeka & Santa Fe, with headquarters at San Francisco, Cal., has had his jurisdiction extended to include the Valley division, and his headquarters have been moved to Fresno, Cal. **E. E. Ball,** division engineer of the Valley division, at Fresno, has retired.

Track

James A. Loughan, a track foreman on the Canadian Pacific, with headquarters at Minnedosa, Man., has been promoted to roadmaster at Virden, Man., succeeding **H. D. Brydone-Jack,** who has been transferred to the office of the comptroller at Montreal, Que.

D. A. McNeill, a section foreman on the Canadian National, with headquarters at Palmerston, Ont., has been appointed roadmaster on the Brampton, Drumbo, Fergus and Waterloo subdivisions of the Stratford division, Southern Ontario district, with headquarters at Stratford, Ont., to succeed **C. H. Muma** who has been transferred to the Forest, Goderich and Thorndale subdivisions of the same division with the same headquarters. Mr. Muma succeeds **I. A. Moody,** retired.

Clayton R. Uitts, whose promotion to supervisor of track on the Pennsylvania, with headquarters at New Castle, Pa., was noted in the July issue, was born on October 1, 1903, at Kokomo, Ind., and received his higher education at Purdue University, from which he was graduated in 1925. He entered railway service on April 12, 1928, as assistant on the engineering corps on the Chicago Terminal division of the Pennsylvania and, on July 23, 1929, he was promoted to assistant supervisor on the Schuylkill division. After serving later in this capacity on the Philadelphia and the Philadelphia Terminal divisions until May 1, 1932, he again became temporarily an assistant on the engineering corps on the Williamsport division. On July 24, 1933, he was again advanced to assistant supervisor on the Middle division where he was located at the time of his recent promotion to supervisor.

M. Kubin, a section foreman on the Canadian Pacific, with headquarters at Revelstoke, B. C., has been promoted to roadmaster at Grand Forks, B. C., succeeding **T. J. Behan,** who has been transferred to North Bend, B. C., to replace **P. Gustafson,** who has been transferred

to Kamloops, B. C. Mr. Gustafson replaces **J. H. Baker,** who has been transferred to Vancouver, B. C., to succeed **H. Vollans,** retired.

H. A. Maclean, a transitman on the Lethbridge division, has been promoted to roadmaster, with headquarters at Empress, Alta., succeeding **G. W. Miller,** who has been transferred to Drumheller, Alta. Mr. Miller replaces **A. McDonald,** who goes to the Laggan subdivision, where he succeeds **J. Daem,** who has been transferred to the Mountain subdivision West. Mr. Daem replaces **O. Birkeland,** who has been transferred to the Shuswap subdivision East.

Hiram B. Russell, whose appointment as supervisor of track on the Grand Rapids division of the Pennsylvania, with headquarters at Kalamazoo, Mich., was noted in the July issue, was born on November 9, 1905 at Chester, Pa. He was educated at Lehigh university and at Franklin and Marshall college and entered railway service on July 3, 1928, as an assistant on the engineering corps of the Buffalo division of the Pennsylvania. Subsequently, he was transferred to the Eastern division and on March 1, 1929, he was promoted to assistant supervisor on the Renovo division. Mr. Russell was then transferred successively to the Eastern division, the Pittsburgh division and the Panhandle division, being located on the latter division at Newcomerstown, Ohio, at the time of his promotion to supervisor of track on June 16.

Peter J. Gogan, whose promotion to track supervisor on the Boston & Maine, with headquarters at Concord, N. H., was noted in the July issue, was born on May 25, 1901, at Milford, N. H., and entered railway service on April 14, 1918, as a trackman on the Boston & Maine, with headquarters at Milford. On May 28, 1923, he was promoted to assistant foreman with headquarters at Cambridge, Mass., and, after being transferred to East Fitchburg, Mass., he became acting foreman at Greenville, N. H., in February, 1924. In April, 1924, he was promoted to foreman at North Leominster, Mass., and after serving in this capacity with various headquarters until September 22, 1928, he was made extra crew foreman on special construction at Mechanicville, N. Y. On December 17, 1928, he was made foreman again, and, on April 1, 1929, he became general foreman of a ballast crew, with headquarters at Boston, Mass. Until March 16, 1933, he acted as general foreman, foreman and extra crew foreman at a number of different points, and was then promoted to assistant supervisor at Concord, Mass., which position he was holding at the time of his recent promotion.

Bridge and Building

Fred C. Ayer, whose appointment as bridge and building supervisor of the La Grande district of the Oregon-Washington Railroad & Navigation Company, with headquarters at La Grande, Ore., was announced in the July issue, was born on November 18, 1876, at Kearney, Neb. Mr. Ayer was educated at the University of Nebraska and entered railway service on June 8, 1899, as a chairman in the maintenance of way department of the Union Pacific. In the following year he was promoted to rodman and in 1901, he was made a levelman. He was further advanced to assistant engineer in 1903, which position he held in the maintenance and construction departments until 1913. Later, beginning in 1913, he held the position of assistant engineer in the maintenance department and in 1928, he was advanced to division engineer in the same department. In 1931, Mr. Ayer was appointed an engineer in the valuation department, which position he held until 1933, when he was made a roadmaster. He was holding the latter position, with headquarters at Marysville, Kan., at the time of his recent appointment as bridge and building supervisor on the O-W R. R. & N.

R. C. Mathis, supervisor of bridges and buildings on the Illinois Central, with headquarters at Vicksburg, Miss., has been promoted to bridge inspector of the system, with headquarters at Memphis, Tenn., succeeding **A. G. Howerton. C. W. Boyce,** bridge and building foreman, has been promoted to supervisor of bridges and buildings with headquarters at Vicksburg, to replace Mr. Mathis.

Obituary

John Nolan, retired supervisor of track on the Grand Trunk Western, died on July 12 at Valparaiso, Ind., following a long illness.

Fred Hartman, roadmaster on the Spokane International Railway, died suddenly of a heart attack on June 22, while on a fishing trip near Sandpoint, Idaho. Mr. Hartman was born on February 26, 1886, at Belknap, Mont. He began his railway career in 1902 as a trackman on the Northern Pacific and for many years was employed in various capacities on track work on western railroads. He entered the service of the Spokane International as a track foreman on March 12, 1916, and was advanced to roadmaster on September 1, 1923, which position he was holding at the time of his death.

Fred C. Baluss, formerly engineer of bridges and buildings of the Duluth, Missabe & Northern, who resigned as office engineer of this company in 1929, died on July 14 at Duluth, Minn., following a long illness. Mr. Baluss was born on September 26, 1871, in Lenawee County, Mich., and entered railway service in 1905 as an instrument man on the Chicago & North Western. Four years later he left this company to go with the D. M. & N. as a draftsman, being advanced to assistant engineer in 1913. In the following year, Mr. Baluss was further promoted to engineer of bridges and buildings, holding this position until 1927, when he was made office engineer. In 1929, he resigned from the service of the company to engage in other business. Mr. Baluss had been active in the American Railway Bridge and Building Association, of which organization he was president in 1927-28.

Harold D. Row, assistant division engineer on the Erie, with headquarters at Huntington, Ind., died suddenly on June 11 while on a vacation. Mr. Row was born on November 8, 1888, at Galion, Ohio, and was educated at Ohio State university. He entered railway service on June 11, 1906, as a supervisor's clerk on the Erie at Galion, being appointed a rodman at Youngstown, Ohio, in the following year. During the next two years, Mr. Row attended college, and in June, 1909, he was appointed assistant city engineer of Galion. In Febraury, 1910, he became a draftsman with E. M. Freese & Co. in the same city, returning to the service of the city in 1912, as assistant city engineer. In June, 1912, Mr. Row again entered the service of the Erie as assistant track foreman at Marion, Ohio, being advanced to assistant division engineer with the same headquarters later in the same year. In 1913, he was made assistant engineer of roadway, bridges and buildings in the office of the general manager at Cleveland, Ohio, which position he held until 1916, when he was appointed track supervisor at Jamestown, N. Y. Two years later, he was again appointed assistant division engineer. He served in this position at Susquehanna, Pa., and Marion, Ohio, until 1920, when he was advanced to division engineer at Marion, later serving in this capacity at Huntington, Ind. In 1922, Mr. Row returned to the position of assistant division engineer at Marion, but was again advanced to division engineer at Huntington in the following year. Since January 1, 1930, he had acted as assistant division engineer at Huntington.

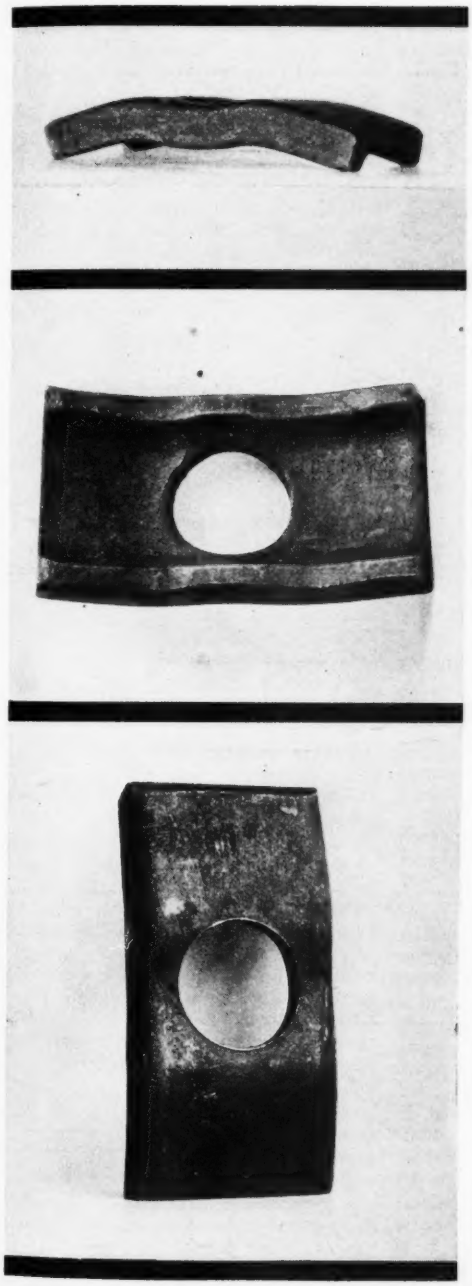
Railroad Expenses Increased Under "New Deal"

Recent acts of Congress have resulted in an increase of approximately $359,000,000 per year in railway expenses, according to a statement issued by the Association of Railway Executives, following a meeting at Atlantic City, N. J., on July 15. On the other hand, it was pointed out that no allowance for this increase in expenses has been made in freight or passenger rates, although other industries have been encouraged to increase prices to compensate for larger expenses.

Railroad Employment in June Shows Increase

The number of employees of Class I railroads as of the middle of the month of June was 1,054,089, an increase of 96,557, or 10 per cent, as compared with the same month of 1933, according to the preliminary monthly tabulation of railroad employment statistics of the Interstate Commerce Commission. The increase over the previous month was 11,025, or 1.06 per cent. As of the middle of June, employment in the maintenance of way and structures group showed an increase of 15.6 per cent, as compared with June, 1933, while the maintenance of equipment group showed an increase of 15 per cent. Employment in the train and engine service group increased only 8.72 per cent.

Two important reasons why VERONA TRIFLEX SPRINGS *should be used*



1. TRIFLEX SPRINGS are calibrated so that equal and proper bolt tension can easily be arrived at and maintained.

   Equal bolt tension will eliminate buckling and pulling apart of track due to severe temperature changes and will provide a means for the better functioning of rail anchors.

2. TRIFLEX SPRINGS have high reactive spring pressure exceeding by more than twice American Railway Engineering Association's specification requirements for spring washers.

   Such high reactive spring pressure will maintain tight joint assemblies when wear takes place in the various parts. VERONA TRIFLEX SPRINGS are not expensive.

Write us for further information.

WOODINGS-VERONA TOOL WORKS

VERONA PENNA.

SINCE *1873*

Supply Trade News

Personal

Stanley H. Smith, Midland Bank building, Cleveland, Ohio, has been appointed representative at Cleveland, for the **Sellers Manufacturing Company,** of Chicago.

L. S. Hamaker, sales promotion manager of the **Republic Steel Corporation,** Youngstown, Ohio, has been promoted to

L. S. Hamaker

vice-president and general manager of the **Berger Manufacturing Company,** Canton, Ohio, a subsidiary, to succeed **J. B. Montgomery, II,** who resigned on June 1. **Stanley A. Knisely** has been appointed sales promotion and advertising manager of the Republic Steel Corporation, to succeed Mr. Hamaker.

Mr. Hamaker entered the sales department of the Berger Manufacturing Com-

Stanley A. Knisely

pany in 1919, later transferring to the advertising department. In 1925, he became advertising manager of the United Alloy Steel Corporation. With the formation of the Central Alloy Steel Corporation by the merging of the United Alloy Steel Corporation with the Central Steel Company in 1926, he was appointed advertising manager of the new company. When the Republic Steel Corporation was organized in 1930, he continued in that capacity. He was later appointed sales promotion manager and continued in charge of advertising.

Mr. Knisely entered newspaper work in his home city of Canton, Ohio, and later held the positions of city editor and telegraph editor of the Cleveland Plain Dealer. He left that field to become advertising and sales manager of the National Paving Brick Association, with headquarters at Cleveland, Ohio. After 6½ years in that position, Mr. Knisely became director of advertising and research for the National Association of Flat Rolled Steel Manufacturers and served seven years in that capacity.

The Woodings-Verona Tool Works and the **Woodings Forge & Tool Company,** Verona, Pa., have opened a Chicago office in Room 648 of the Peoples' Gas building, 122 South Michigan avenue. This office will be in charge of **R. J. McComb,** sales manager of the Woodings-Verona Tool Works, and will supervise the sale of products of both companies in the Middle West and West, as well as direct the sale of products of the Woodings Forge & Tool Company to railroads in Chicago and vicinity.

Obituary

Joseph B. Card, president of the Indiana Wood Preserving Company, Terre Haute, Ind., died at Highland Park, Ill., on June 10 of pneumonia.

Harry L. McCauley, district sales manager at Milwaukee, Wis., of the Inland Steel Company, died from drowning on June 24 at the age of 44. After working in the Gary, Ind., sheet mills of the American Sheet & Tin Plate Company, Mr. McCauley was employed in May, 1920, at the Chicago office of the Inland Steel Company. On May 1, 1924, he was transferred to the Milwaukee office, as assistant district sales manager and in March, 1928, he was made district sales manager.

Edmund K. Swigart, senior vice-president of the **Bucyrus-Erie Company,** South Milwaukee, Wis., died of heart disease on July 7 while on a fishing trip in Northern Wisconsin. Mr. Swigart was born on April 16, 1867, at Bucyrus, Ohio, and spent 10 years in railway mail service. He joined the Bucyrus-Erie Company in 1891 and 10 years later was made secretary and treasurer. In 1910, Mr. Swigart was made a joint managing director of the company and in the following year he was elected senior vice-president, which position he held until his death. He also founded the Oilgear Company in 1921, and was chairman of the board of that concern at the time of his death.

Trade Publications

Structural Metal Painting.—The National Lead Company, New York, has issued, in compact pocket size, 5½ in. by 3⅜ in., a thorough treatise on structural metal painting, which should be informative and helpful to all those who have anything to do with the protection and preservation of the metal structures on the railways, whether through the specification of protective coatings or in the actual application of the protective materials themselves. The booklet, of which A. H. Sabin and F. M. Hartley, Jr., are co-authors, includes 160 pages and discusses the subject under 219 headings, indexed for the convenience of the user. Some of the major divisions of the booklet, which indicate its broad scope, are as follows: Theories of corrosion, conditions affecting paint life, the science of paint, paint formulation, facts about paint materials, testing, judging the value of paints, types of painting work, estimating areas and costs, preparing the surface, mixing red lead paint, paint application, and formulas.

Cranes—The American Hoist & Derrick Co., St. Paul, Minn., has published two attractively illustrated booklets covering various units of its equipment. One of the booklets, containing 16 pages and entitled "American Equipment," deals with the various applications of the different cranes manufactured by this company, while the other, containing 12 pages and entitled "The American Eagle Crane," is devoted exclusively to this one piece of equipment.

I-Beam-Lok.—A new type of bridge roadway and heavy duty slab, known as the I-Beam-Lok armored slab, is treated in a 24-page illustrated booklet recently issued by the Carnegie Steel Company, Pittsburgh, Pa. The booklet first traces the development of this type of construction and then describes it in detail. It includes a large amount of useful design data and gives specifications for a concrete that is designed to give the best results when used in connection with the I-Beam-Lok slab.

Enduro Stainless Steel.—The Republic Steel Corporation, Massillon, Ohio, has issued a 16-page attractively printed and illustrated brochure containing useful data concerning Enduro 18-8 stainless steel as well as several of the more important variations which make up the 18-8 series of types. An important feature of the booklet is a table of laboratory corrosion data listing the degree of corrosion-resistance of stainless steel to more than 300 chemical reagents, solutions and products under varying conditions of temperature and concentration.

Rail Defects.—Sperry Rail Service, Brooklyn, N. Y., has issued a simply presented yet comprehensive manual on rail defects. Published essentially for maintenance of way forces charged with the detection and classification of defective rails, the manual clearly illustrates the various types of defects and in each case discusses briefly the manner of occurrence and importance of the defect, its cause and how it progresses, and how to identify it before and after the rail is broken. The manual, in pocket size, is assembled in loose-leaf form with flexible leatherette covers, permitting the ready addition of supplemental data from time to time. Cost—in quantity lots, including any supplemental sheets which may be published, 35 cents.

Correct track alignment under high speeds

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THE higher speeds of trains today have made more difficult the problem of maintaining correct alignment of track on curves and at turnouts. While elevating the outside rail on curves lessens the tendency to spread and "kick out" at joints, the dependable way of holding the rails in position is to use gage rods.

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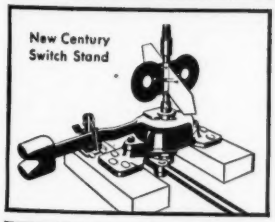
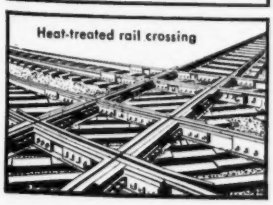
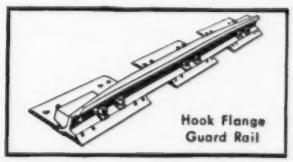
The Bethlehem Gage Rod is a one-piece forging hooked at one end and threaded at the other end to receive an adjustable clip, which is held tightly in position positively by a Unit lock nut. When it is to be used at electric interlocking switches, or other locations where there is a track circuit, the Bethlehem Gage Rod is furnished with an insulated clip.

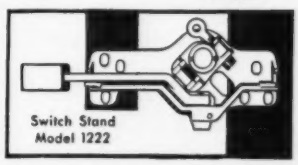
Bethlehem manufactures track equipment to answer completely and satisfactorily every requirement of the modern railroad. Each item of Bethlehem Track Equipment—whether gage rod, switch stand, heat-treated rail crossing, guard rail, or what not—conforms to high standards of excellence and reliability and has behind it a record of satisfactory performance on representative roads. *Bethlehem Steel Company, Bethlehem, Pa.*

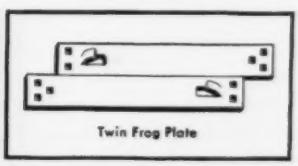
OTHER BETHLEHEM TRACK EQUIPMENT











BETHLEHEM *Track Equipment*

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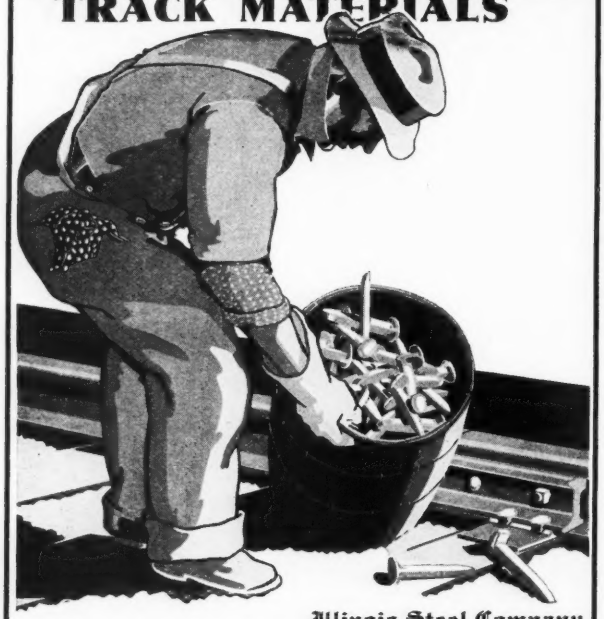

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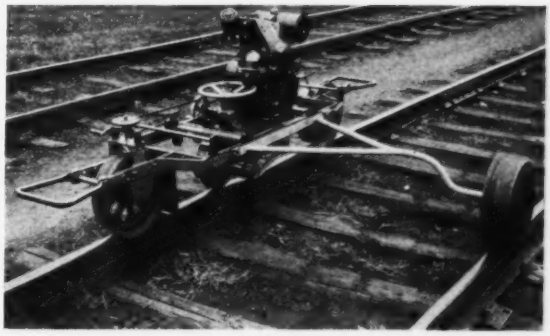

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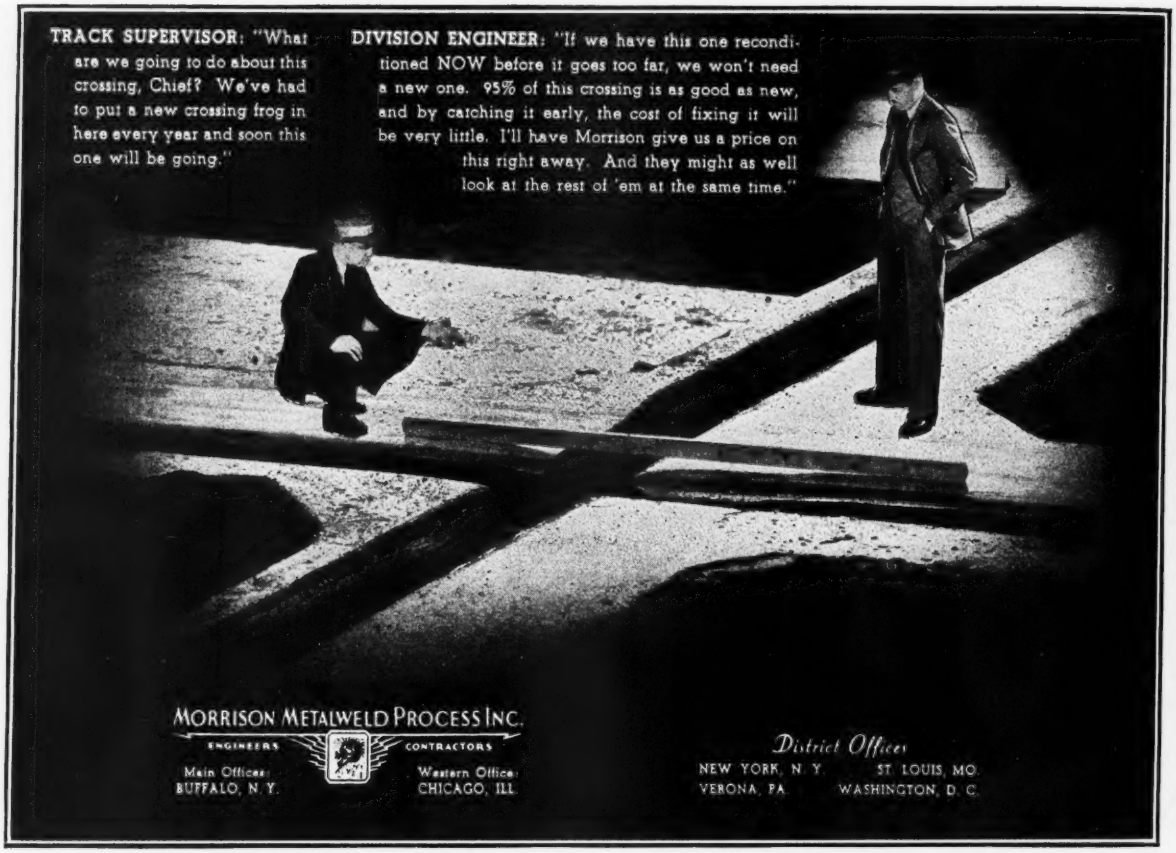
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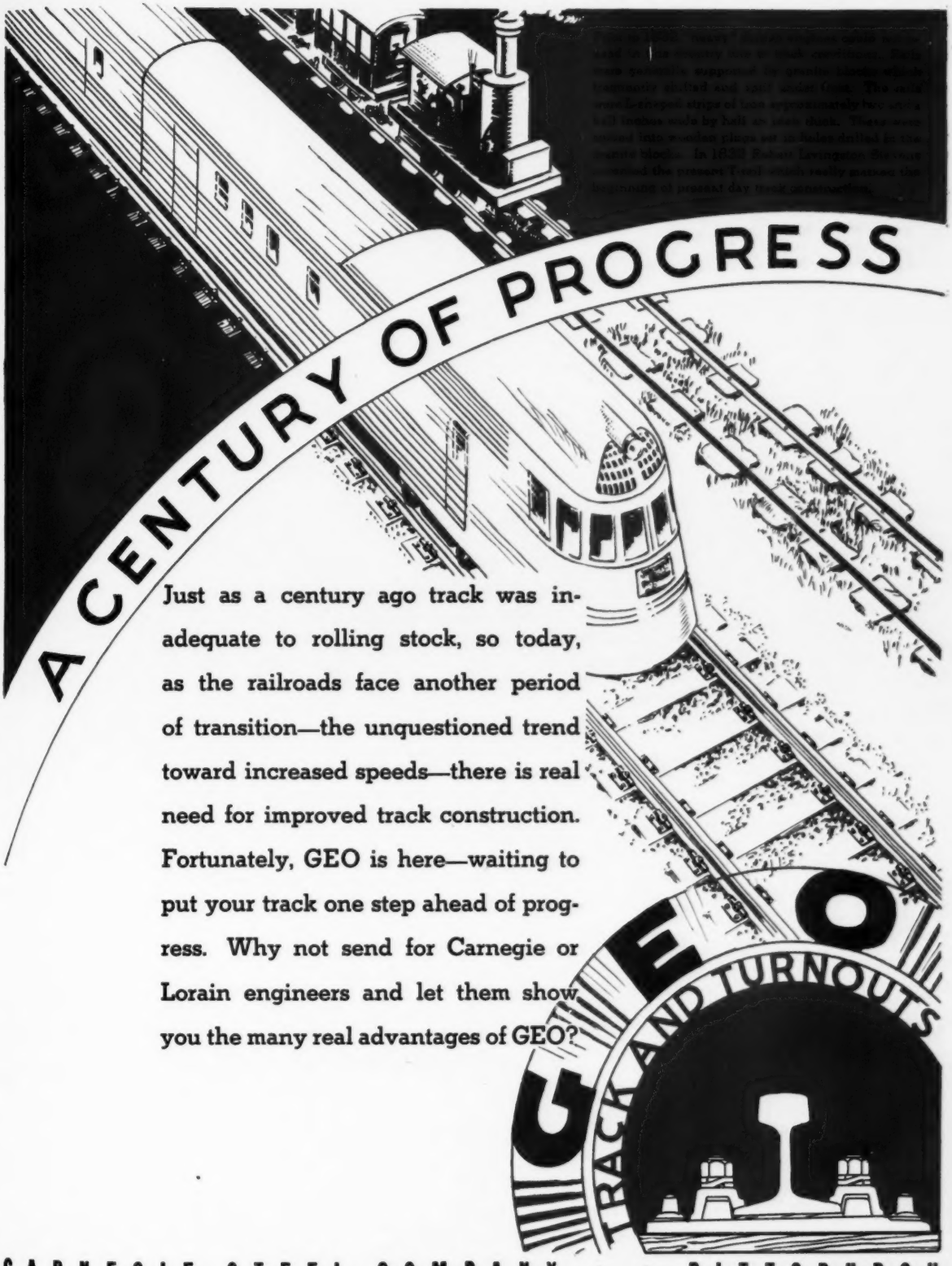

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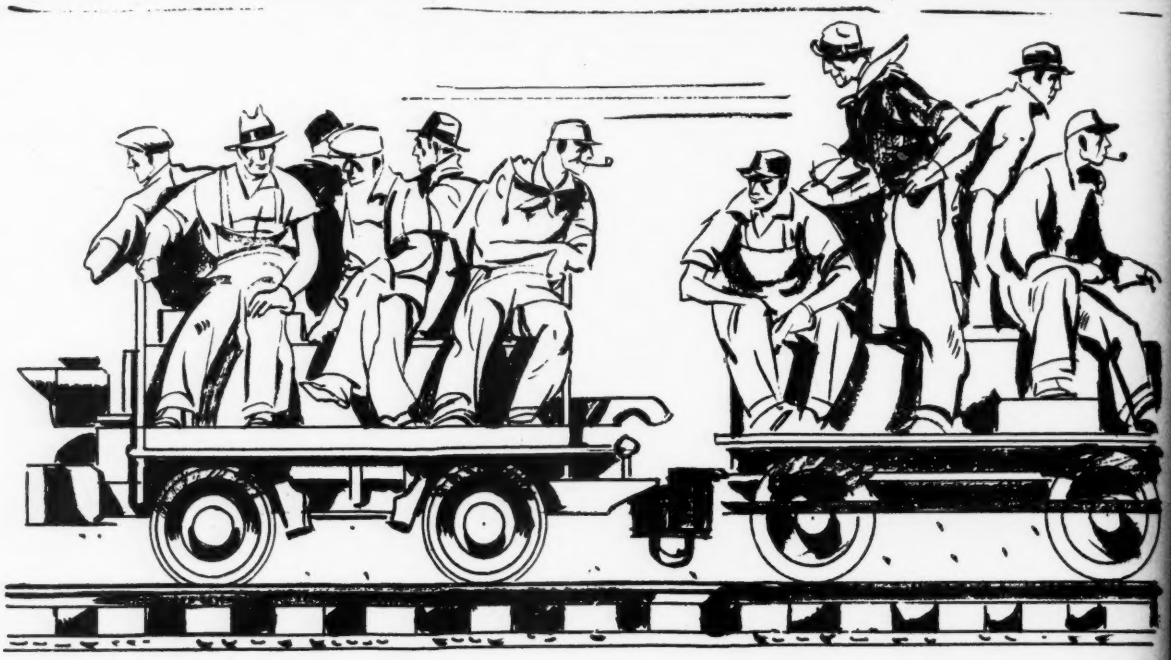

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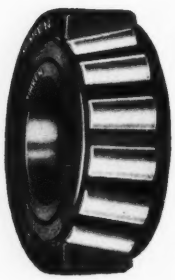

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